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Action Biology

Stanley L. Weinberg—Herbert J. Stoltze

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Dedicated by the authors to their enduring wives and patient children.

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1 STAINING BLOOD

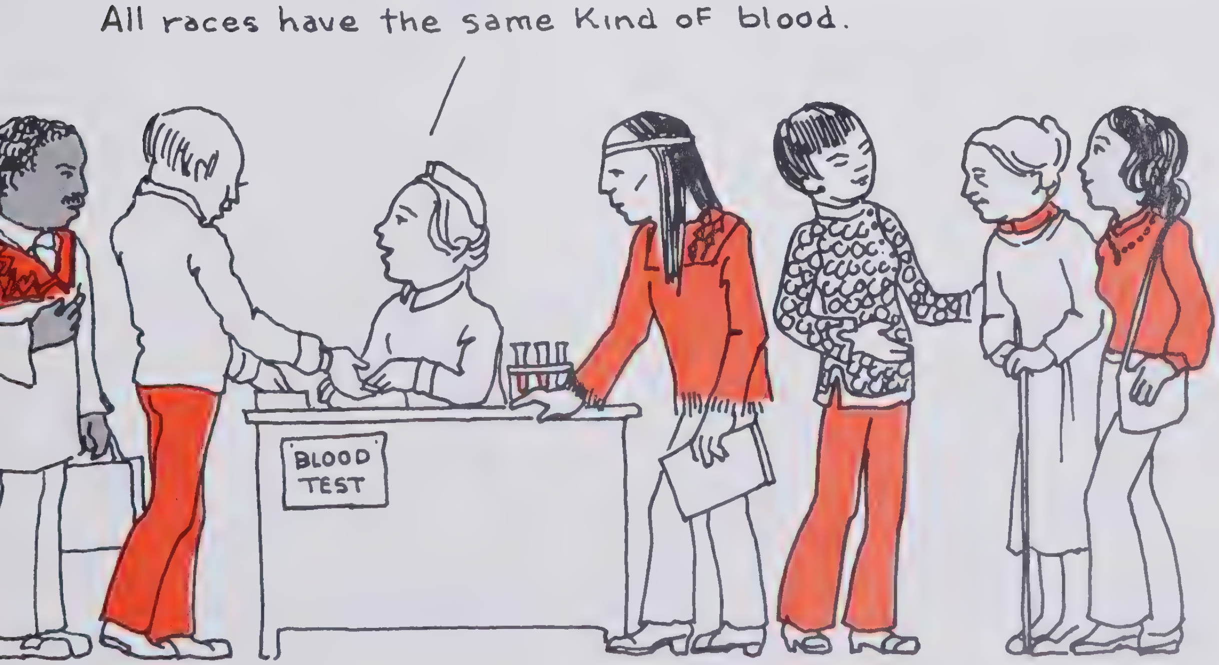
word guide

laboratory	*LAB-ruh-tawr-ee*
technician	*tek-NISH-uhn*
plasma	*PLAZ-ma*

You already know something about blood. When you cut yourself, you see the blood run out.

PATTY CHOCK

1. What color is blood? Is there a difference in the color of blood if your skin is yellow, or brown, or white, or black?
2. Is the blood warm or cool? Can you think of one way that blood helps the body?
3. Is blood solid or liquid?


All races have the same Kind oF blood.
BLOOD TEST

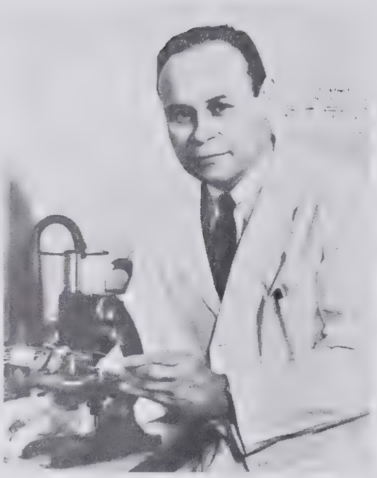
A. WHAT'S IN THE BLOOD?

You couldn't possibly be wrong on question 3. You have 6 liters (6 quarts) of blood running through your body. It reaches every cell. It helps to keep the body cells alive.

Half of the blood is a yellowish liquid called **plasma.** Plasma is mostly water, but it is also loaded with chemicals.

The body cells need some chemicals. The other chemicals are waste materials. The plasma carries wastes away from the body cells.

The other half of the blood consists of soft, solid little specks called blood cells. You need a microscope to see them.



COURTESY HOWARD UNIVERSITY

Dr. Charles R. Drew set up early blood banks.

B. THE BLOOD LAB

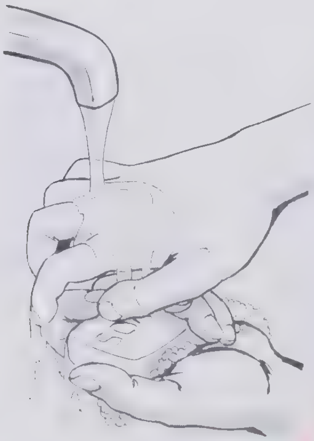
When you go for a medical examination, the doctor often tests a sample of your blood. If you are sick, blood tests help tell the doctor what is wrong with you. A **laboratory technician** does the blood tests. First the lab technician draws a little blood.

You might do this also. Drawing blood is safe when done carefully. But carelessness can cause infection. So follow directions exactly.

To see blood cells well, you must make a slide. This is called a blood smear. You dye or stain the smear. Instead of using your own blood, you may use already prepared blood that the teacher provides.

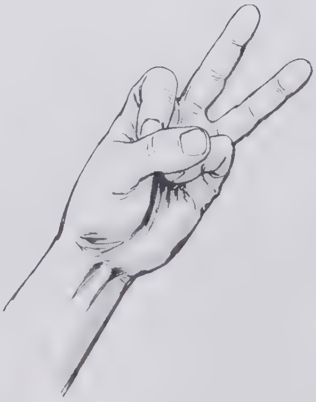
To get ready, first read the DRAWING-BLOOD ACTIVITY. Then, in your notes, outline what you are going to do.

DRAWING-BLOOD ACTIVITY



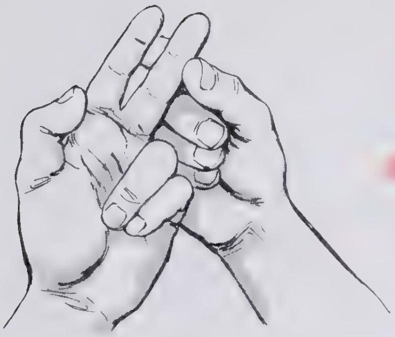
A

Wash hands with soap and water. Instead, if you use already prepared blood, start with step I.



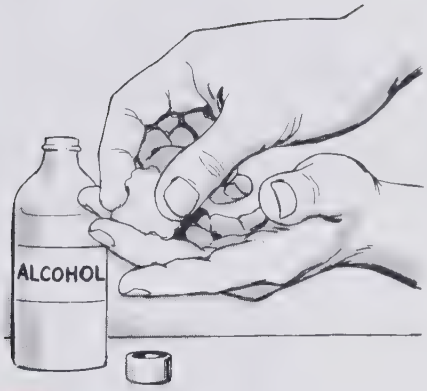
B

Draw from these fingers on your left hand if right-handed. Switch if left-handed.



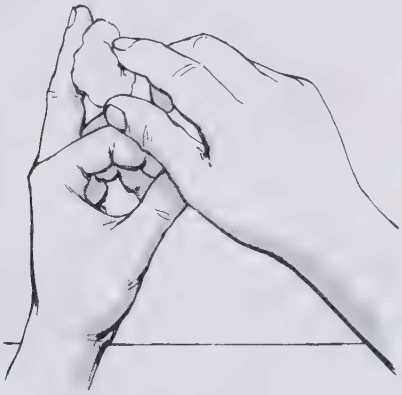
C

Rub finger to stimulate blood flow.



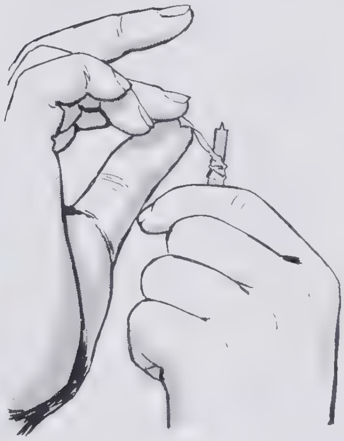
D

Sterilize with alcohol.



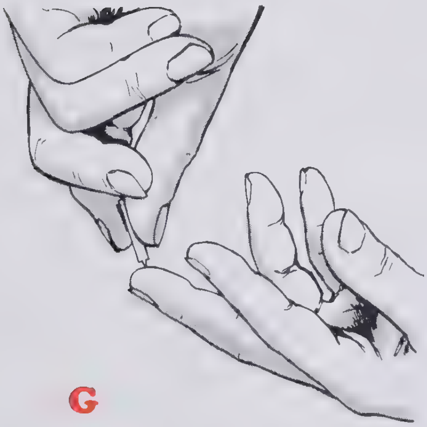
E

Dry finger.



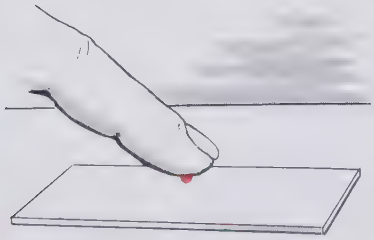
F

Do not touch tip of sterile lancet. Discard lancet after one use.



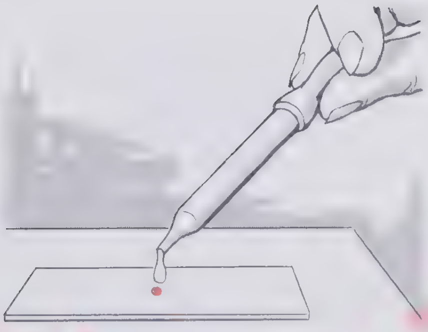
G

One quick, firm jab.



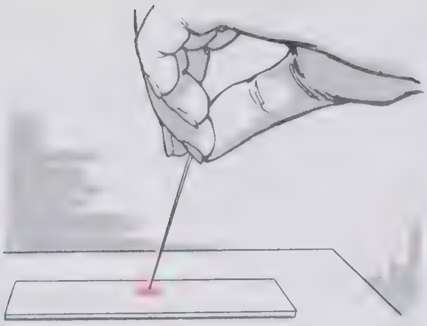
H

Place small drop of blood in center of clean slide.



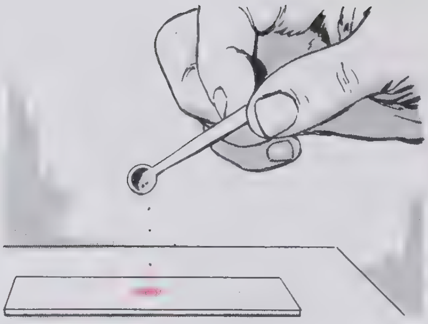
I

Add drop of water to drop of blood.



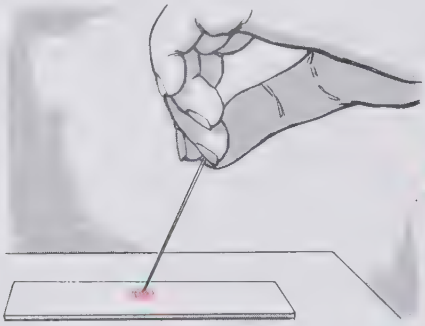
J

Mix with toothpick for 30 seconds.



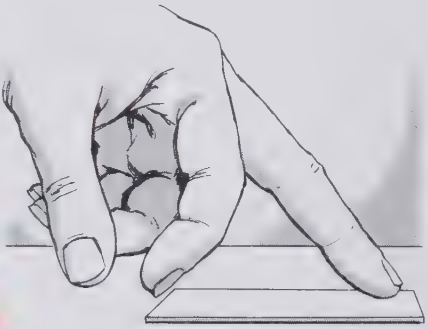
K

Add 5 salt crystals.



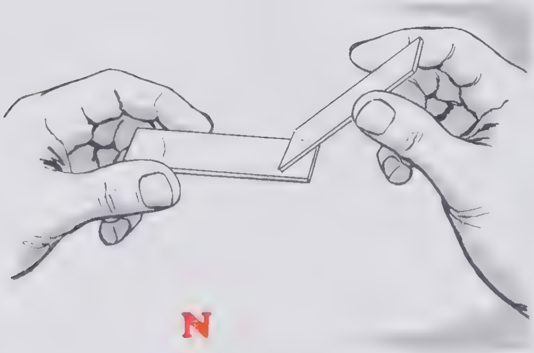
L

Continue mixing until dissolved. When dry, label slide and save for future examination.



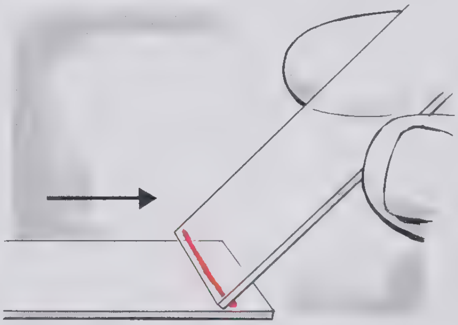
M

Take another clean slide and place a drop of blood near end.



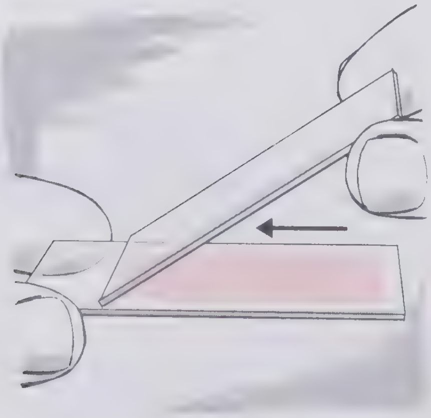
N

Take a spreader slide and pull toward drop.



O

Watch blood fill angle.

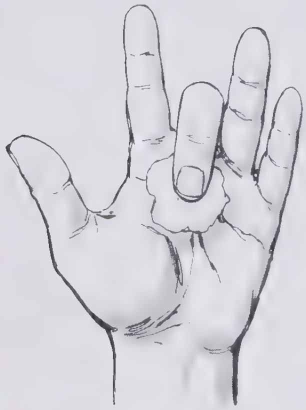


P

Slowly and smoothly, PUSH spreader away from drop. Watch blood spread evenly.

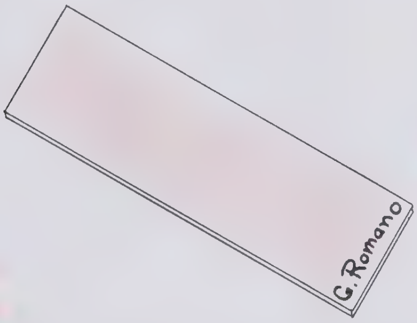
Q

Sterilize again with alcohol.



R

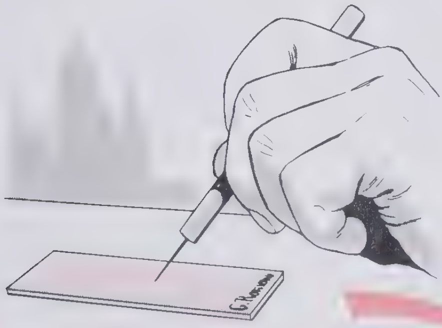
Hold cotton in place for 3 minutes.



S

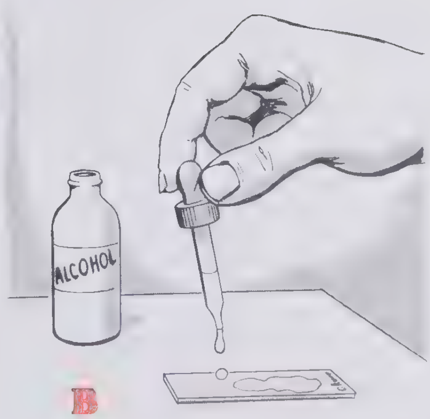
Label and save the blood smear for the staining activity.

STAINING-BLOOD-CELLS ACTIVITY



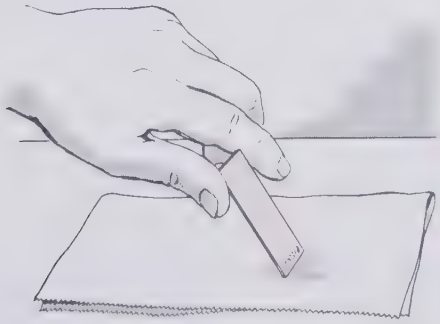
A

Scratch slide to find side with smear.



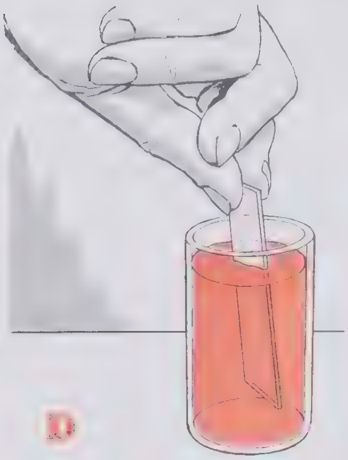
B

Cover smear with alcohol. Leave 2½ minutes.



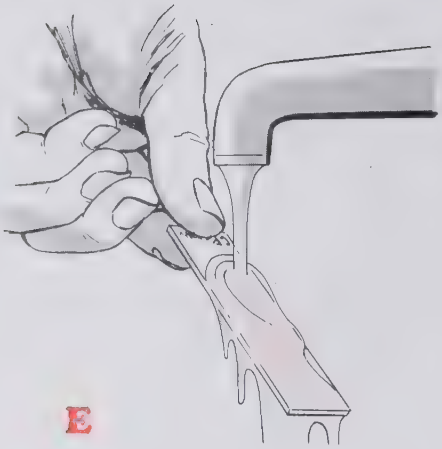
C

Drain on paper towel.



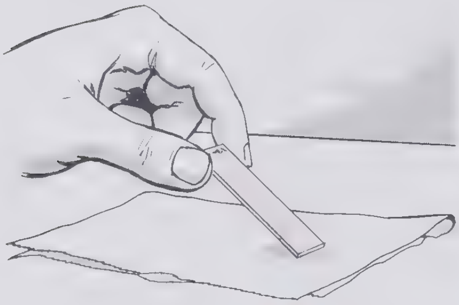
D

Dip in red stain for 6 seconds.



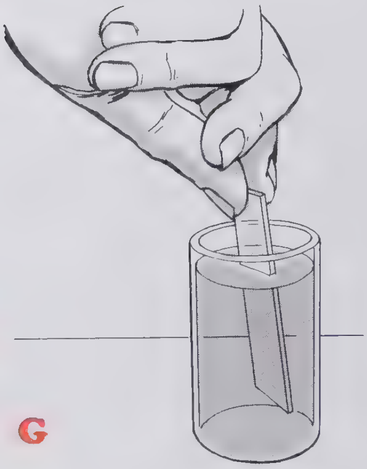
E

Gently rinse slide.



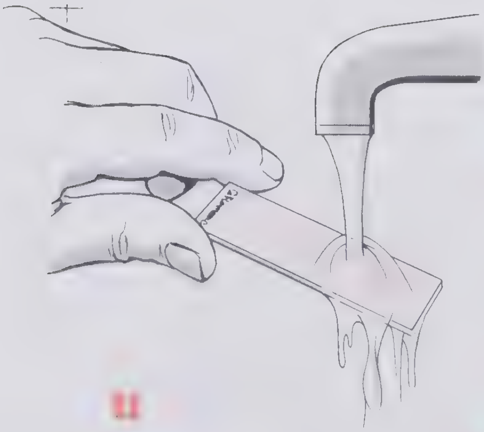
F

Drain.



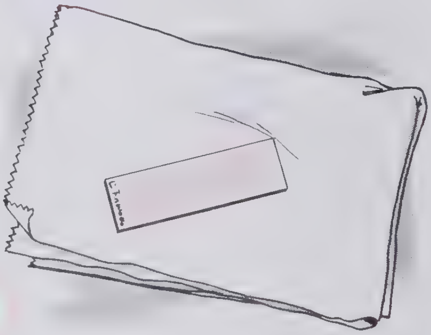
G

Dip in blue stain for 6 seconds.



H

Rinse and drain.



I

Dry in air. When dry, the smear can be examined with a microscope.

2 LOOKING AT BLOOD CELLS

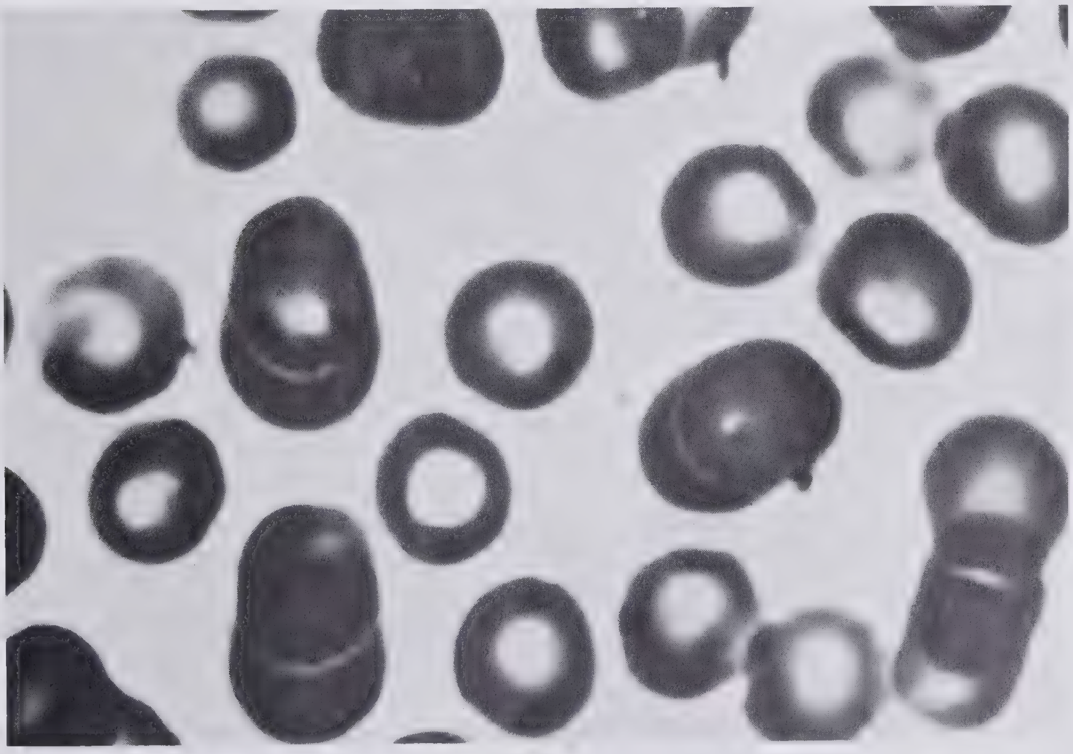
Examine your stained blood smear with a microscope.

word guide

diagnosis	*dy-uhg-NOH-sis*
hemoglobin	*HEE-muh-gloh-bin*
nuclei	*NOO-klee-y*
platelets	*PLAYT-lits*

A. RED BLOOD CELLS

Most of the blood cells you see on the smear are red cells. They get their natural color from a chemical called **hemoglobin.** The hemoglobin carries oxygen from the lungs to the body cells. These cells need oxygen to stay alive.



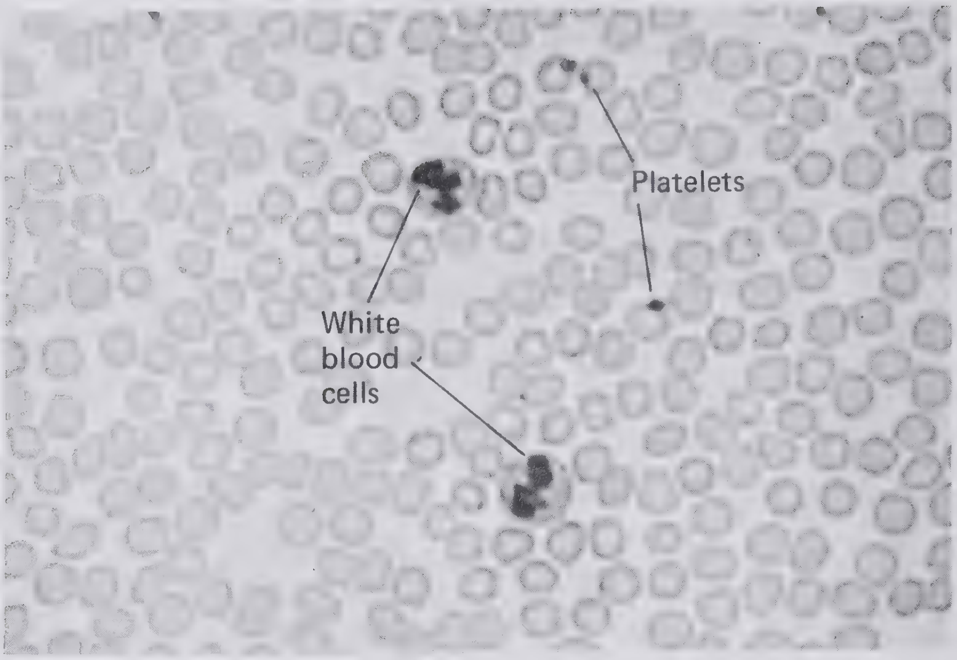
NATIONAL INSTITUTES OF HEALTH

The colors you see on the smear are not natural.

1. Why not?

The smear shows the natural shape of the red cells. This shape is unusual.

2. Draw a few red blood cells as they appear on the smear.
3. What is their shape?

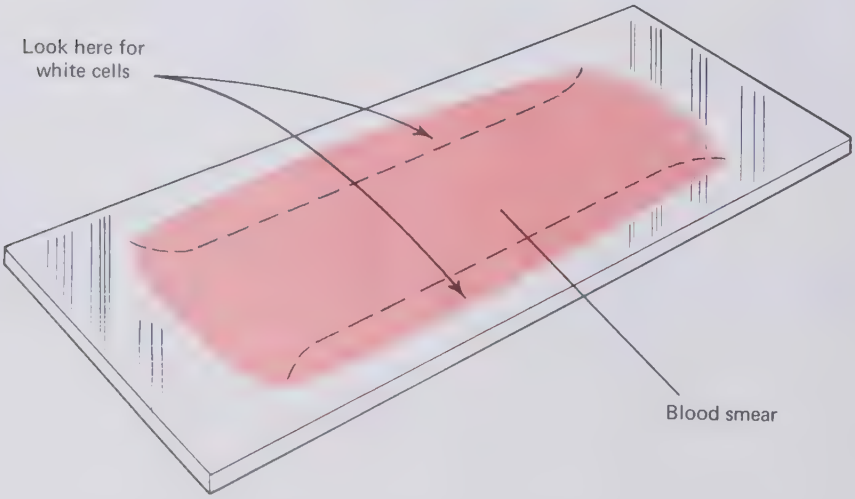


COURTESY CAROLINA BIOLOGICAL SUPPLY COMPANY

Scattered among the red cells you can see a second type of blood cell. This blood cell is made up of very tiny blue-stained specks. These are called blood **platelets.** You will see how the platelets keep you from bleeding to death.

B. PINK AND BLUE

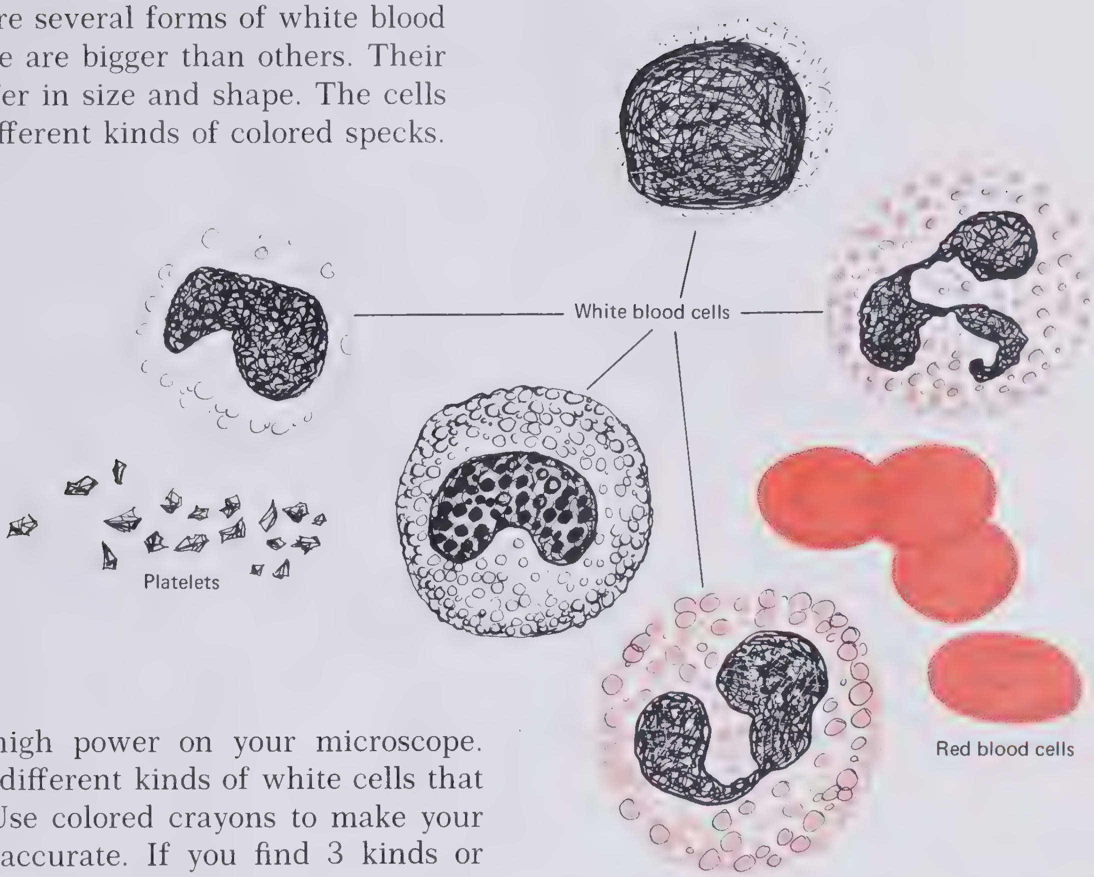
Now look at the edges of the smear for a third type of blood cell. Find some cells colored pink and blue. These cells are called "white" blood cells. Their centers or **nuclei** are blue.



4. Why do the white cells look pink and blue rather than white?

White blood cells fight and eat germs that invade your body. Pus contains a lot of dead white cells. Pus is a sign of infection.

There are several forms of white blood cells. Some are bigger than others. Their nuclei differ in size and shape. The cells contain different kinds of colored specks.



Use the high power on your microscope. Draw the different kinds of white cells that you see. Use colored crayons to make your drawings accurate. If you find 3 kinds or more, you are doing great!

C. COUNTING IN MILLIONS

Sometimes the doctor orders a "blood count" on a patient.

Thirty trillion blood cells stream through your body. Yes, you read that number right—30,000,000,000,000. Every second, 3 million of them wear out and are replaced.

It is impossible to count all the blood cells in your body. What does the technician count?

As you can probably guess, the cells in only a small sample of blood are counted.

The counting is done on a special slide. Your teacher can explain to you how this slide is used.

COURTESY—AMERICAN OPTICAL CORPORATION

Special blood-counting slide set

This is how some large numbers are read:

1,000	one thousand
10,000	ten thousand
100,000	one hundred thousand
1,000,000	one million
1,000,000,000	one billion
1,000,000,000,000	one trillion
30,000,000,000,000	thirty trillion

After making the count, the technician does some figuring to help the doctor with the **diagnosis.** The BLOOD COUNT WORKSHEET will help you understand what the technician and the doctor are trying to do.

Blood Count Worksheet

Here is some information about blood that a good technician should know:

Men normally have about 5 million red cells in a small drop (1 cubic millimeter) of blood. Women have about 4½ million.

Some people have too few red blood cells, or too little hemoglobin in their cells. Their bodies are starved for oxygen. This disease is called anemia. When this condition exists, we say the person is anemic.

The same small drop of blood has about 7,000 white cells. This number can vary too.

Leukemia is cancer of the blood. In this condition the number of white cells increases perhaps a hundred times.

A drop of blood normally has about 35,000 platelets.

Pretend you are a lab technician. Using the above information, how would you answer these questions?

1. A male patient has a red cell count of 3 million. Why is he tired all the time?
2. How can the lab technician help the doctor diagnose anemia?
3. A female patient has a bad infection. Her white cell count is 23,000. Why is this high count important?
4. Another patient has a white cell count of 3,500. What danger is the patient in?
5. What is the ratio of red cells to white cells in a healthy man? What is the ratio in a healthy woman?
6. A patient sick with leukemia has 30 times the normal white cell count. How many white cells does the patient have in a drop of blood?
7. What is the normal ratio of platelets to white cells?
8. Why doesn't question 7 state the sex of the person?

D. GET IT ALL TOGETHER

You have been reading some terms that are useful to a lab technician. Now get it all together. Tell your group what you know about:

Blood
Blood plasma
Blood cells
Blood count
Red blood cells
Hemoglobin
Blood platelets
White blood cells

Write out some large numbers. See if others in your group can say them correctly.

3 WHEN YOU BLEED

When you bleed from a cut, the bleeding does not last very long. This is a good thing.

It is not just luck. When blood hits the air outside the body, a blood clot begins to form. A substance in the blood called **fibrin** hardens into sticky threads. The threads form the framework of the clot. Blood platelets trigger this clotting process. The clot is a built-in hole stopper.

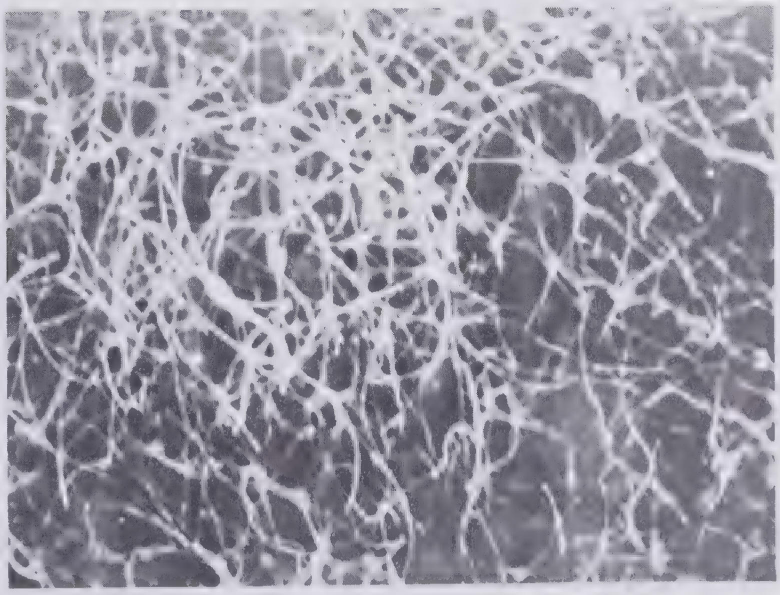
word guide
fibrin
FY-brin

"I've got a built-in hole stopper."

A. FORMING A CLOT

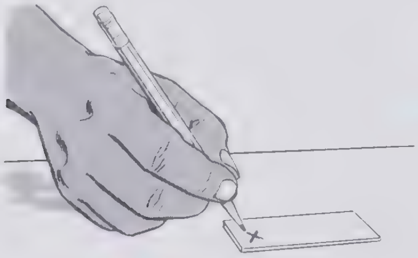
You can watch your blood form a clot. You will have to work fast, however, because the process begins in seconds.

Seen through a microscope, fibrin threads form framework of clot.



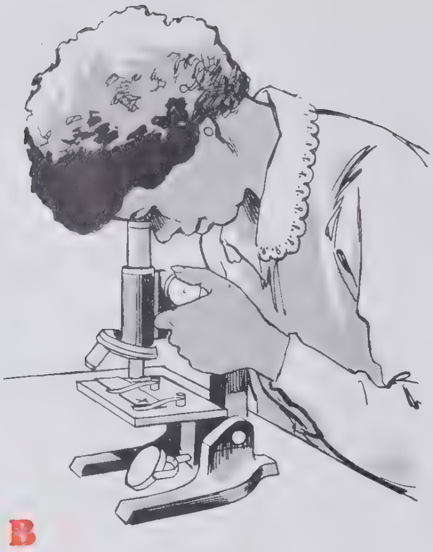
S. GOLLUB, Ph.D., M.D. AND CLARA SCHAEFFER, M.S., DEPT. OF NUCLEAR MEDICINE, ST. BARNABAS HOSPITAL, N.Y., N.Y. AND THOMAS L. HAYES, Ph.D., DONNER LABS, UNIVERSITY OF CALIFORNIA, BERKELEY, CALIFORNIA

BLOOD-CLOTTING ACTIVITY



A

Mark an X near one end of a slide.

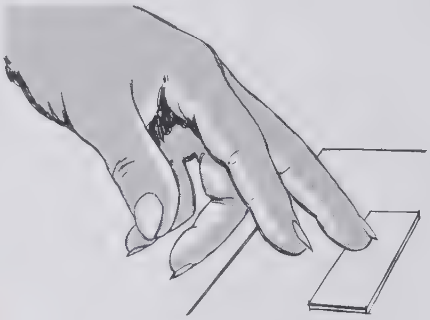


B

Focus on X with low power. Remove slide. Leave microscope in focus.

C

Puncture finger SAFELY as you have learned.

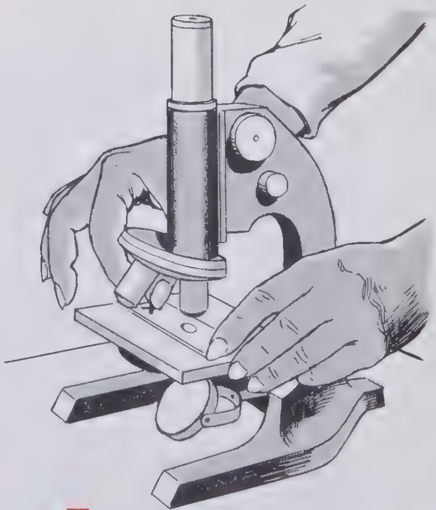


D

Place one drop of blood in middle of slide. No cover slip needed.

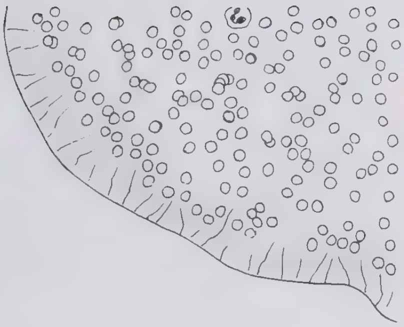
E

Sterilize finger as you have learned.



F

QUICKLY place slide on microscope.



G

Notice the thin black fibrin threads among cells AT VERY EDGE OF DROP.

H

Watch at intervals for 20 minutes, as fibrin threads change and clot forms.

1. How do the fibrin threads change as the clot grows?

The black threads you saw forming are made of fibrin. Fibrin is protein.

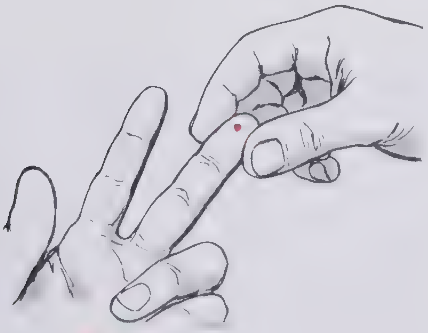
2. When a blood clot forms over a cut, what does it hold within the body?
3. What does the clot keep out of the body?

B. CLOTTING TIME

People differ in the amount of time it takes for their blood to clot. Clotting time depends on several factors. It depends on how many blood platelets and how much calcium and vitamin K you have in your blood.

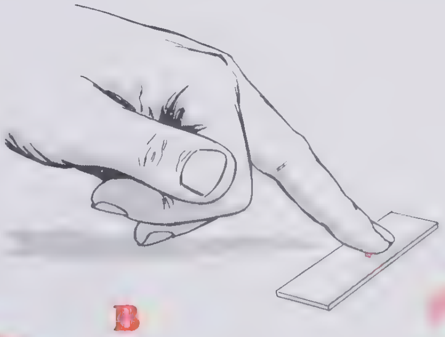
You can measure your clotting time and compare it with the clotting time of others in the class.

CLOTTING-TIME ACTIVITY



A

Squeeze a drop of blood from puncture.



B

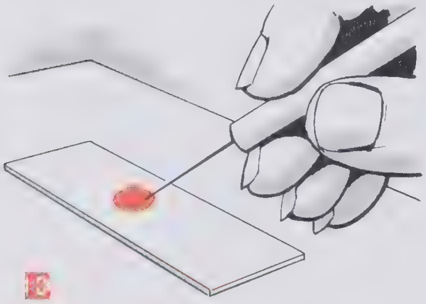
Place drop in middle of slide.

C

Record the time in seconds.

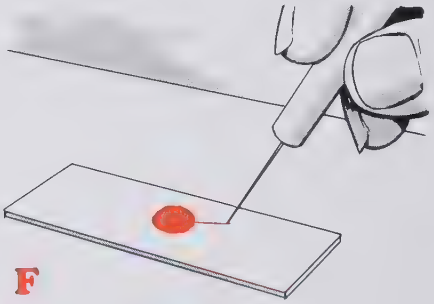
D

Sterilize finger as you have learned.



E

Every 30 seconds pull a clean needle through the drop.



F

When needle pulls a thread of fibrin from drop, clotting has begun.

4. What was your clotting time?

G

Record clotting time on class chart.

5. What is the average clotting time of the class?
6. How does your clotting time compare with the class average?
7. People with slow clotting time may have bleeder's disease. Why is this a serious condition?

Blood clots sometimes form inside the body. Usually this occurs when a part of the body is injured. Air is not needed for this to occur. A black eye is an example.

8. Is this kind of clot good or bad? Why?

This is how to figure average clotting time:
Suppose 5 students report
the following times:

		Minutes
		7
		$4\frac{1}{2}$
		6
		2
		$5\frac{1}{2}$
Add the 5 clotting times	→	25
Divide by 5, the number of students	→	$5\overline{)25}$ with ? above
The average is	→	5 minutes

4 WHAT'S A BUFFER?

word guide

buffer
BUF-uhr

Probably you have seen commercials on TV that talk about **buffers.** Maybe you have wondered, "What's a buffer?"

After you have seen a buffer at work, you will know.

Buffers control chemicals called acids and bases.

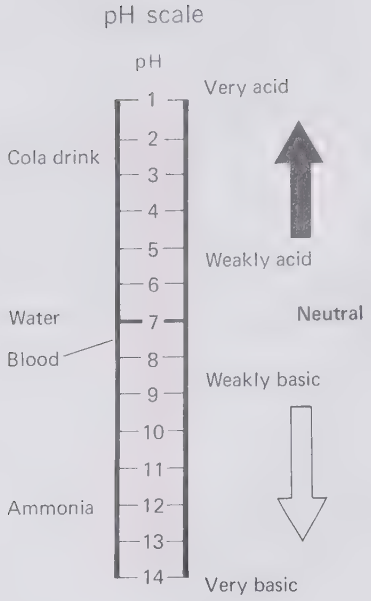
A. ACID AND BASE

Strong acids can burn. But we drink weak acids such as cola, vinegar, and orange juice. Even these weak acids could do harm inside the body if it weren't for buffers.

Bases can burn too. Bleach and ammonia are bases. Buffers also control bases.

Acids and bases are opposites, the way hot is opposite to cold. Just as lukewarm water is between hot and cold, so there are "neutral" chemicals that are between acid and base.

Student lab technicians measure acids and bases.



B. MEASURING ACIDS AND BASES

Lab technicians measure the strength of acids, bases, and neutral substances. They use a set of numbers called the pH scale.

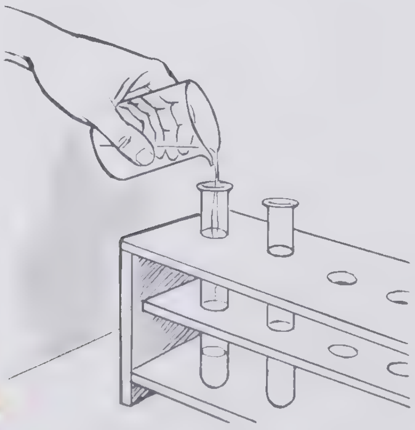
pH 1 indicates a strong acid. Find 1 on the pH scale. pH 4 measures a weaker acid. pH 7 indicates a neutral solution, neither acid nor base. pH 14 indicates a strong base.

Look at the pH scale and test yourself on these 2 questions:

1. What does pH 10 measure?
2. Pure water is neutral. Where is water on the pH scale?

Blood fits into the scale too. Its pH has to stay close to 7.4. Blood is slightly basic. If the pH drops below pH 7, the person dies. If the pH rises above 7.8, it is just as dangerous. Then why don't acid drinks such as cola harm us?

pH-AND-BUFFER-ACTION ACTIVITY



A

Pour 2 cm (one inch) of water in test tube. This water has same pH as blood.

B

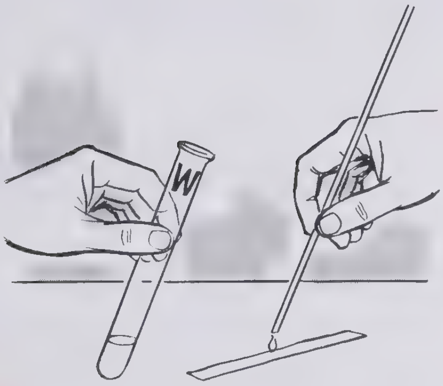
Pour same amount of blood plasma in another tube.

C

Label test tubes "W" (water), "B" (blood plasma).

D

Place a clean glass rod in each test tube.



E

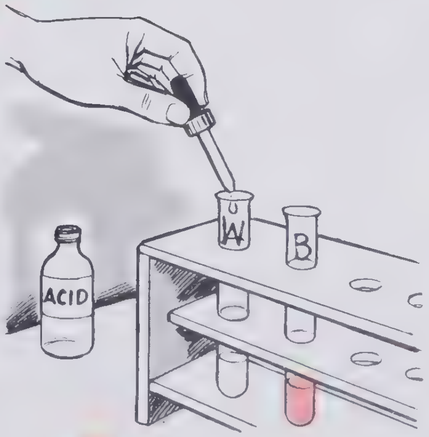
Use glass rod to test pH. Place one drop from W tube on red litmus paper. Base makes red litmus turn blue.

F

Add one drop of acid to W tube.

G

Stir W tube. Test with litmus.



H

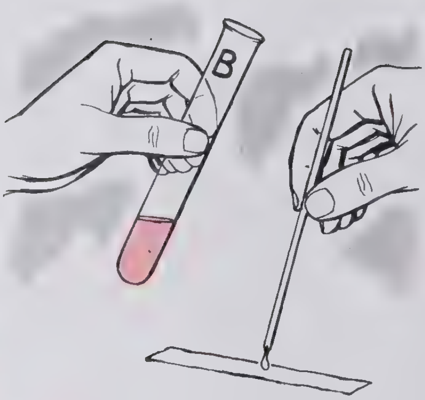
Repeat steps F and G. Test pH after each drop. Count drops.

BUFFER ACTION

	Water	Blood Plasma
Original pH (acid or basic)		
Number of drops of acid required to change pH		

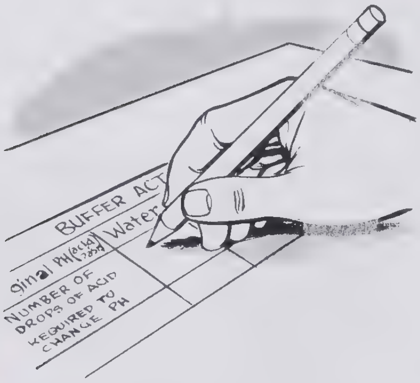
I

When litmus paper stays red, W tube has become acidic. Copy the table and record number of drops required.



J

Test B tube the same way.


BUFFER ACT
Water
ginal pH(acid/basic)
NUMBER OF DROPS OF ACID REQUIRED TO CHANGE PH

K

Record number of drops of acid soaked up by blood plasma until the litmus paper stays red.

3. Which liquid absorbed more acid before changing its pH and turning acid itself?

L

EXTRA. Test the pH of cola, milk, sink water, orange juice, ammonia, bleach, and other liquids.

A buffer can soak up a lot of acid or base without changing its pH.

4. Tell in your own words what we mean when we say that blood is a good buffer.
5. What is an acid? Name some acids.
6. What is a base? Name some bases.

5 CRIME LAB

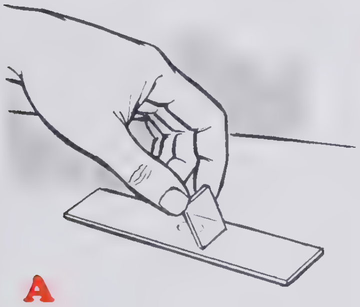
COURTESY MASS. STATE POLICE

Lab technicians from the police crime laboratory are often called to the scene of a serious crime. They can decide whether or not a certain stain was made by blood.

word guide

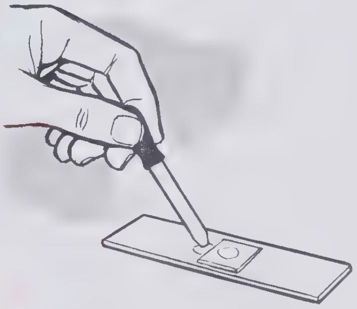
hemin
HEE-muhn

IDENTIFYING-BLOOD-STAINS ACTIVITY



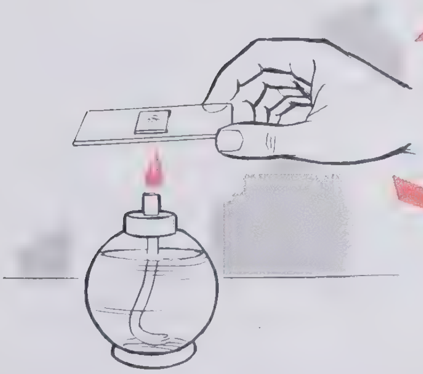
A

Take your Crime Lab slide. Add a cover slip.



B

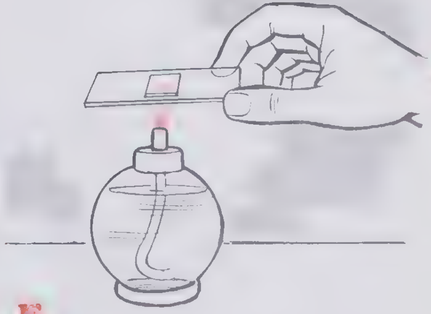
Fill space under cover slip with glacial acetic acid. (CAREFUL! KEEP ACID AWAY FROM EYES AND SKIN.)



Warm GENTLY about one minute, until gas bubbles appear. (KEEP EYES AWAY FROM SLIDE!)

D

Add ONE MORE DROP of acid.

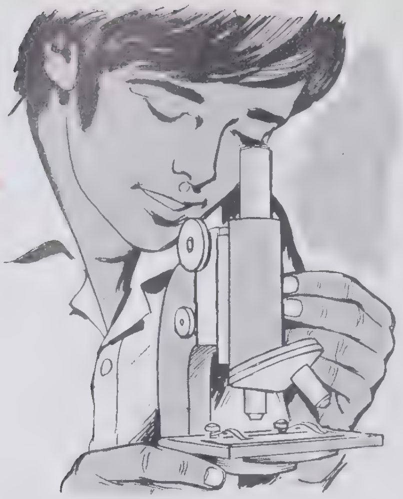


E

Warm until faint red-brown color appears.

F

Wait a few minutes until slide feels cool.



G

Examine for **hemin** crystals. These identify bloodstain.

1. Draw several hemin crystals. Make your drawings accurate enough so that another technician could identify them.
2. The hemin crystals come from hemoglobin. What color are they?

H

Get mystery slide from teacher. Test it for bloodstain.

3. Does it have a bloodstain?

Test-Yourself Worksheet

What have you learned about blood? In your notes write one of the following 4 letters that best fits each numbered statement.

A. Red blood cells
B. White blood cells
C. Blood plasma
D. Blood clotting

1. Liquid part of blood
2. About 5 million in a drop of blood
3. Number increases during infection
4. Gives blood its red color
5. About 7 thousand in a drop of blood
6. Pale yellow
7. About 3 minutes
8. Carries food
9. Carries oxygen
10. Doughnut shaped
11. Contains buffers
12. Contains hemoglobin
13. Fibrin network
14. Eats germs
15. Platelets
16. Too many cause leukemia
17. Hemin crystals
18. Nucleus stains blue
19. Keeps germs from entering cut
20. Too few cause anemia

How Well Can You Say It?

Pick one of the following topics. Write a paragraph about it. Then read the paragraph to your teacher, group, or class.

1. Good and bad points about blood clots.
2. Why I would make a good lab technician.
3. How blood helps the body cells.
4. How to identify a blood stain.
5. How to draw a blood sample without getting infected.
6. Blood as a buffer.

6 THE HEART PUMP

Make a fist. Relax it. Make a fist again. Relax it. Can you feel the muscles tightening as your fist clenches?

Your heart is a hollow mass of muscles. Your heart is about as big as your fist. As the heart contracts and relaxes, it pumps blood around the body.

How does your heart do its important job? There are various HEART ACTIVITIES at stations around the room. Each activity will show you something about the heart pump.

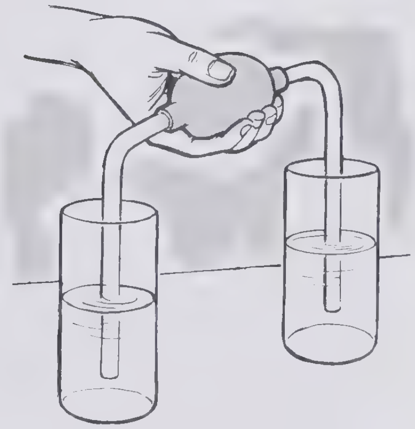
Your group will do each of the activities. In your notes, answer the questions found on the HEART WORKSHEET.

word guide

arteries	*AHR-tuhr-eez*
capillaries	*KAP-uh-ler-eez*
circulation	*suhr-kyuh-LAY-shuhn*
vein	*VAYN*

HEART ACTIVITY A

Squeeze the bulb.
Watch what happens to the water.
Before you leave this activity, pour the water back the way you found it.



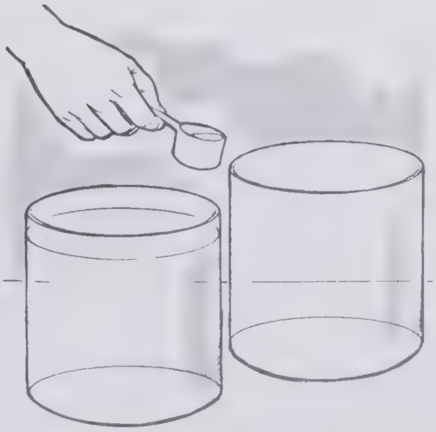
HEART ACTIVITY B

With each beat your heart pumps 60 milliliters ($\frac{1}{4}$ cup) of blood.

Each minute your heart pumps 5 liters (5 quarts) of blood around your body.

Can you match this record with your hands? Try it. Use the $\frac{1}{4}$-cup container. See how much water you can remove from the large jar in one minute.

When your group finishes, refill the jar.



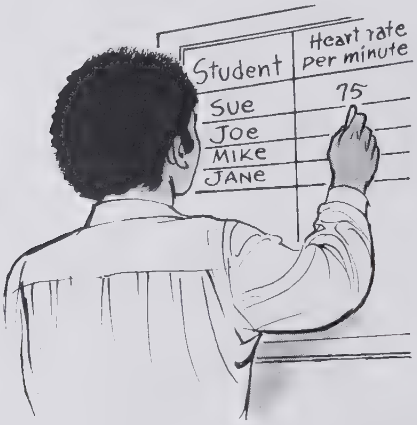
HEART ACTIVITY C

Learn how a doctor examines the heart.

1. Listen to the heartbeat with a stethoscope. A doctor calls the heart sounds "lub dub."

2. Time each person's heartbeat for one minute—or 30 seconds and multiply by 2.

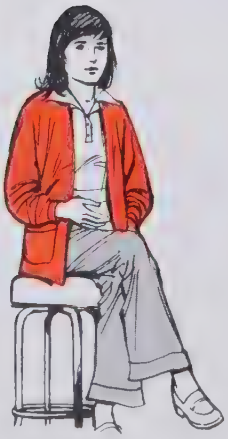
3. Record the heart rates on the board.



HEART ACTIVITY D

Cross your legs like the girl in the picture. This makes your foot beat in time with your heart.

Time the beat of your foot for one minute—or for 30 seconds and multiply by 2.



HEART ACTIVITY E

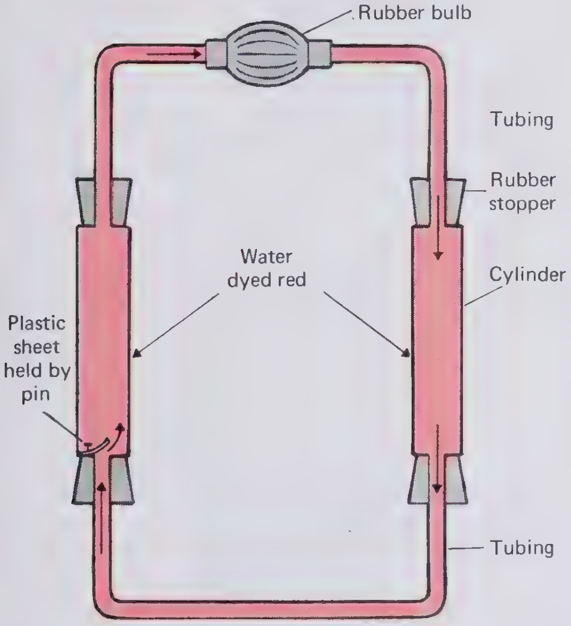
Try to record your heartbeat on a tape recorder.

Exercise. Then record the beat again.

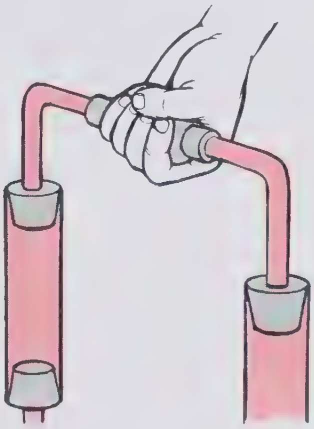
Later, play the tape to the class.

HEART ACTIVITY F

1. Set up this working model of the **circulation** system.



2. Work the heart model until you see something happen.



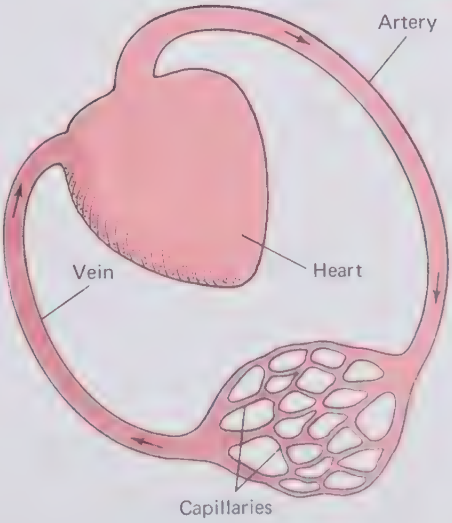
3. Notice the direction in which the blood flows.

Examine the model. Find out what makes blood flow in one direction.

The model shows 3 kinds of tubes that carry blood around the body. **Veins** carry blood toward the heart. **Arteries** carry blood away from the heart.

As arteries get farther from the heart, they branch into the smaller arteries. The smallest arteries branch into **capillaries.**

Capillaries join together and connect with veins. The veins then carry the blood back to the heart. So blood travels in a circle. That is why we speak of it as circulation.



HEART WORKSHEET

HEART ACTIVITY A

1. As you squeeze the bulb, what happens to the water?
2. What does the water represent?
3. Why is this demonstration called a Heart Activity?

HEART ACTIVITY B

4. About how much water did you remove in one minute?
5. Could you match the record of your heart?

HEART ACTIVITY C

6. What is your heart rate per minute?
7. Compare your heart rate with the class average.

HEART ACTIVITY D

8. How many times did your foot beat in a minute?
9. Compare your foot beat with your heart rate.
10. What do you think causes the foot beat?

HEART ACTIVITY E

11. How did exercise change your heart rate?
12. Do you think exercise is good for your heart?

HEART ACTIVITY F

13. Blood leaves the heart through an artery. In the model, is the artery always the same tube?
14. Name the tube that carries blood back to the heart.
15. Were you able to find what keeps blood flowing the right way? Explain what you found out.

HEART MATH

16. You found your heart beats _____ times a minute. It beats _____ times per hour. (1 hour = 60 minutes.) It beats _____ times per day. (1 day = 24 hours.) It beats _____ times per year. (1 year = 365 days.) It has beaten _____ times in your lifetime.
17. Your heart pumps about 5 liters of blood in a minute. How many liters does it pump in an hour? in a day? in a year?

7 TUBES FULL OF BLOOD

word guide

anesthetic	*an-uhs-THET-ik*

Press your finger into your palm. Watch the skin turn pale, and then turn red again.

Blood flowing under the skin causes the red color. When pressure drives the blood deeper into your body, your skin turns pale.

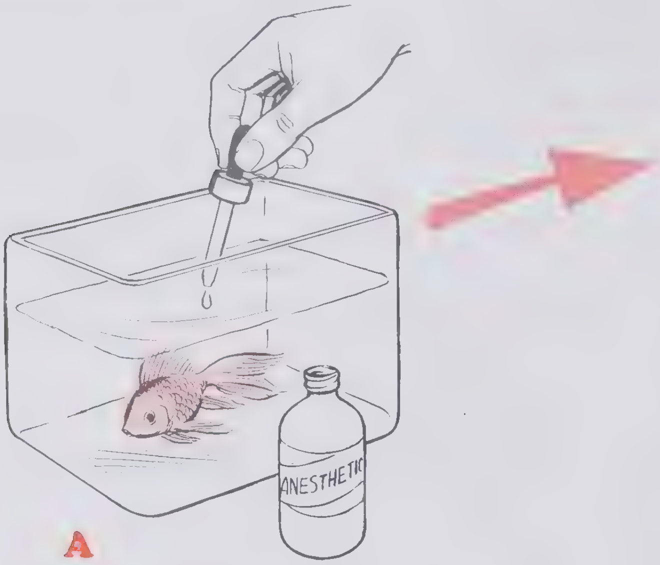
What good does the flowing blood do? What path does it follow?

The blood comes from damaged capillaries.

A. THE GOLDFISH TAIL

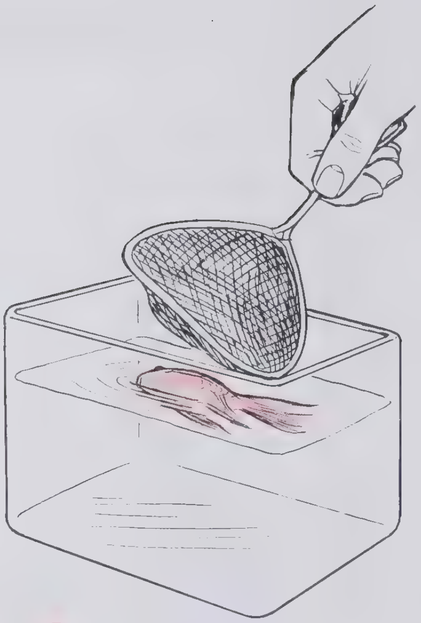
When you cut any living part of your body, you cut some capillaries. These tiny tubes are found in every part of the body. Capillaries help the blood reach every cell. The blood supplies the cells with all their needs. Blood flows in other animals just as in human beings. You can see it easily in the tail of a goldfish.

GOLDFISH ACTIVITY



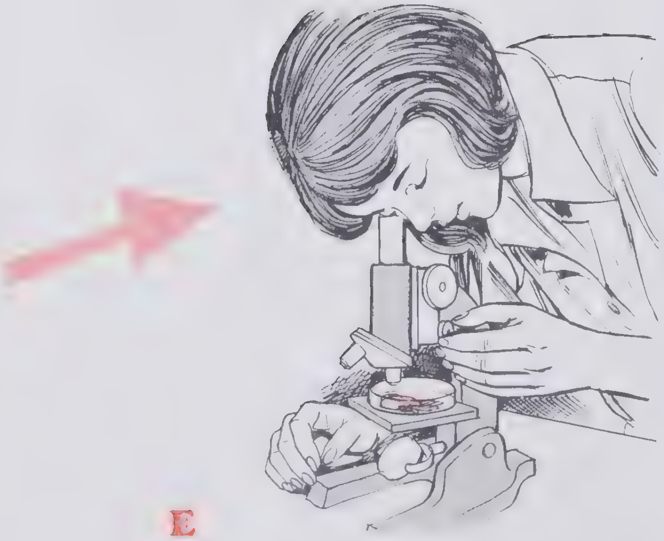
A

Add **anesthetic** to knock out goldfish.



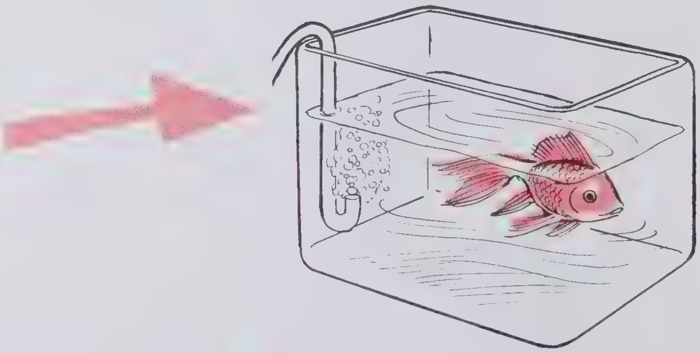
B

Remove fish when it rolls on its side.



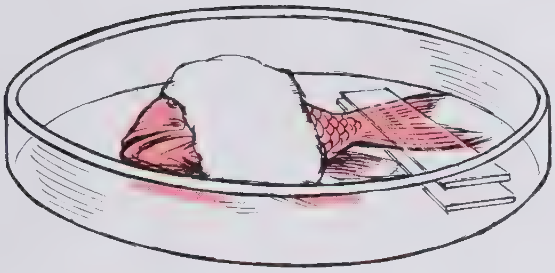
E

Look for blood flow near edge of tail. Large red masses are not blood. What are they?



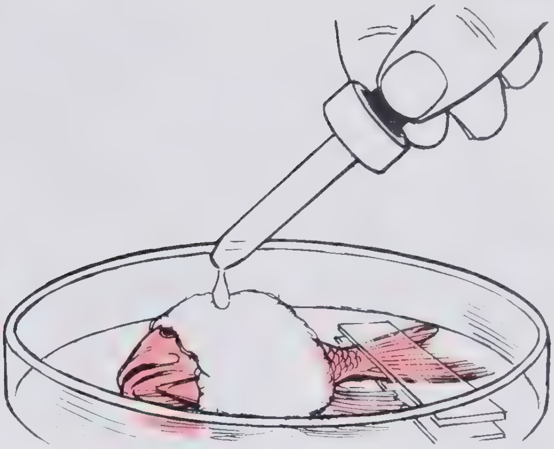
F

If blood stops flowing, revive fish in water without anesthetic.



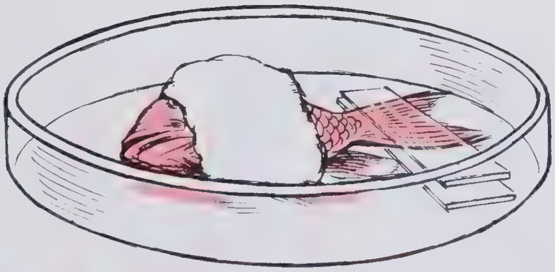
C

Wrap in cotton, as shown, with tail placed lightly between slides.



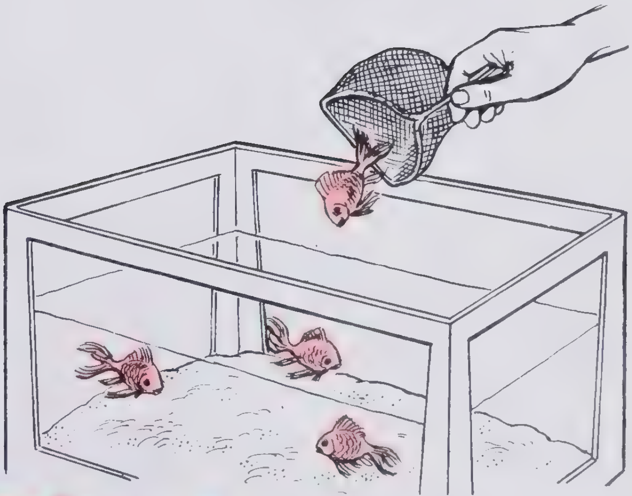
D

Keep cotton wet and the fish will live.



G

Then carefully wrap it again.



H

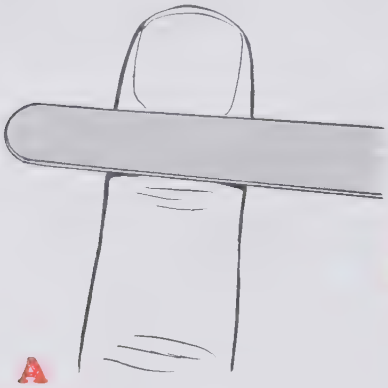
When finished, return fish safely to tank.

1. In what parts of the fish's tail did you see capillaries?
2. How did you recognize them?
3. How did you recognize the blood cells?
4. How wide are the smallest capillaries compared to the blood cells?
5. Does blood flow continuously within a capillary?
6. Does it always flow in the same direction?

B. SEE YOUR CAPILLARIES

Blood doesn't run freely through the body. In the goldfish you saw it flowing within capillaries. With a little effort you can see your own capillaries.

FINGERNAIL ACTIVITY



A

Remove dead skin at bottom of fingernail by gently rubbing with emery board.

B

Rub one or 2 drops of oil of wintergreen on this area.

C

Use microscope to find capillaries. Draw the fingernail capillaries.

7. Can you explain 2 ways in which capillaries are helpful in the body?

8

HAVE A HEART

"Have a heart, teacher!"
"I'm heartbroken."
"What a heartache!"
"You're a sweetheart!"

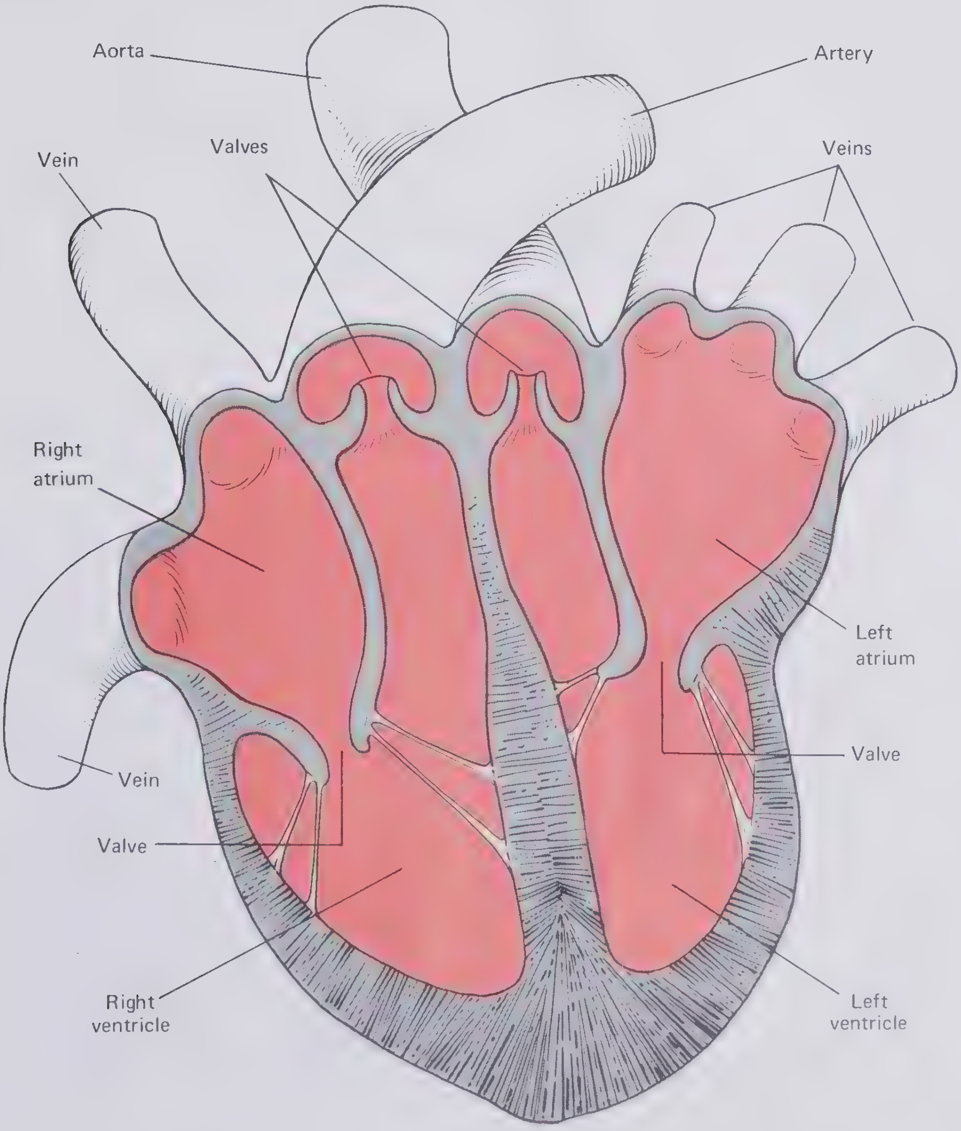
word guide

atrium	*AY-tree-uhm*
cholesterol	*kuh-LES-tuh-rohl*
coronary	*KAHR-uh-ner-ee*
valve	*VALV*
ventricle	*VEN-tri-kuhl*

We've all heard expressions like these.

Many people think that the heart is the center for emotions such as love, anger, and sorrow. It really isn't. The heart is important because it is the center of circulation.

Slice through heart shows 4 chambers.



A. THE DOUBLE PUMP

The heart is divided into 4 rooms or chambers. The 2 top rooms stick out like ears, one on each side. Each chamber is called an **atrium.**

The 2 big bottom chambers take up most of the heart. These chambers are called **ventricles.**

Let's follow the blood as it goes through the heart.

The blood enters the heart through the veins. It collects in the right atrium and left atrium. Then it flows into the 2 ventricles.

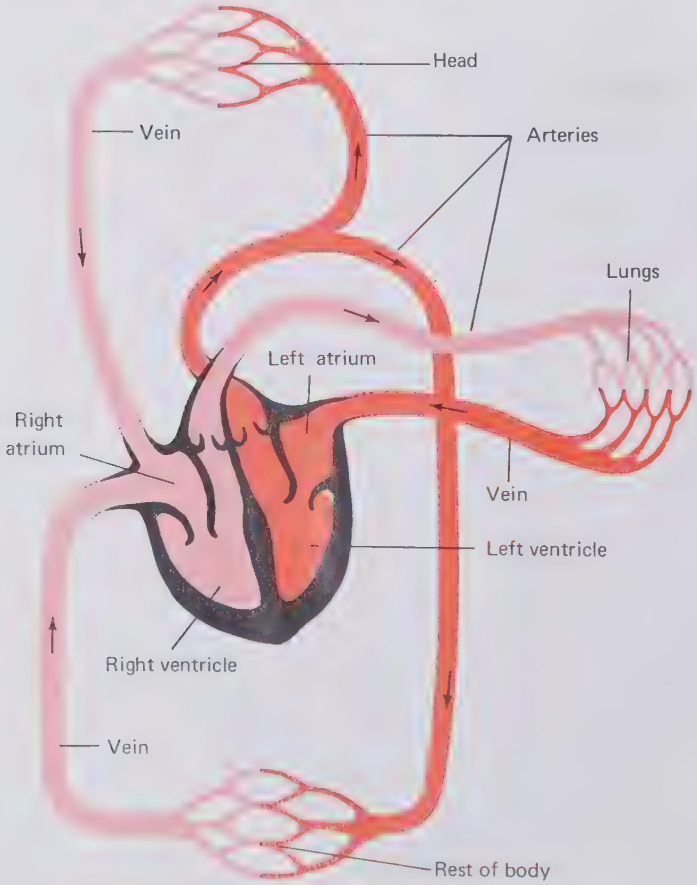
The muscular walls of the ventricles contract. The blood is squeezed out through arteries.

Each ventricle pumps blood to a different part of the body. The right ventricle sends blood to the lungs. The blood spreads through the lung capillaries. Then it returns to the left side of the heart.

The left ventricle sends blood to all other parts of the body. The blood returns to the right side of the heart.

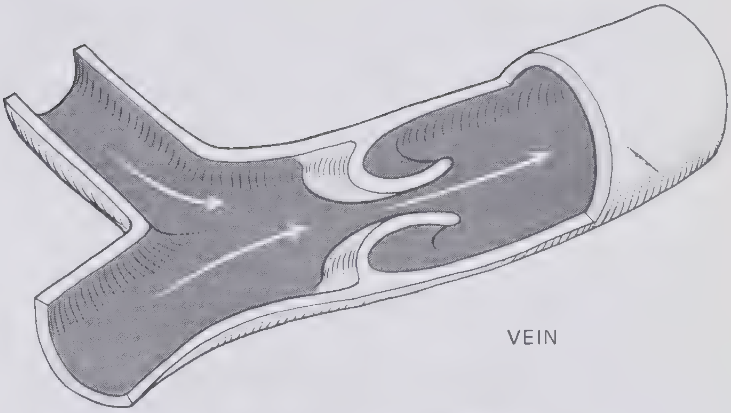
Each side of the heart is really a separate pump, although both sides beat together. Normally the 2 sides are not connected.

The double circulation of the blood



B. YOU HAVE VALVES

The blood travels through the heart in the right direction because there is a **valve** at the exit of each chamber. There are valves in the veins also. A valve is like a one-way door. It lets the blood flow in only one direction.

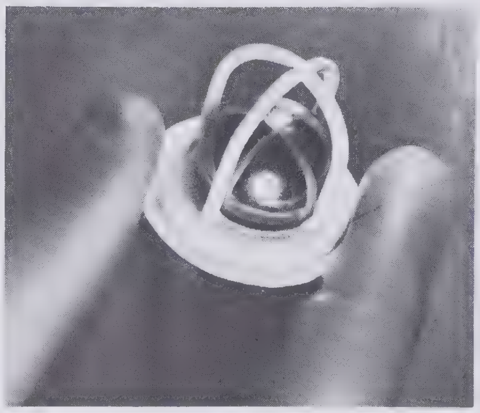


C. VALVE JOB

Sometimes, when a heart valve doesn't close tightly, it lets blood trickle backward. A doctor can hear this with the stethoscope. Such a trickle is called a heart murmur.

A person with a heart murmur cannot play certain games. One of the valves doesn't close properly. This birth defect may heal in time.

If not, surgery may be able to help. An artificial spare part, like this plastic valve, can be sewn into the heart to replace the badly damaged part.


NATIONAL INSTITUTES OF HEALTH

Artificial valve

D. HEART SURGERY

Dr. Daniel Hale Williams was the first surgeon to open the chest and successfully repair a knife wound of the heart.

Many heart operations are now done while the heart continues to beat. These operations are called "open heart surgery."

PROVIDENT HOSPITAL & TRAINING SCHOOL ASSOCIATION, CHICAGO

Daniel Hale Williams

NATIONAL INSTITUTES OF HEALTH

Open Heart Surgery. Patient is covered with drapes. Surgeons and nurses are working on the 'stilled' heart and lungs whose functions have been taken over by the Heart-Lung Machine shown upper right.

For other heart surgery, something has to take over the work of the heart while it is out of action. The heart-lung machine keeps the blood circulating for several hours. It also fills the blood with oxygen, a job that the lungs normally do.

Blood flows through heart-lung machine.

MASSACHUSETTS GENERAL HOSPITAL

SOUTH AFRICAN INFORMATION SERVICE

Blaiberg with rugby football team

E. TRANSPLANTS

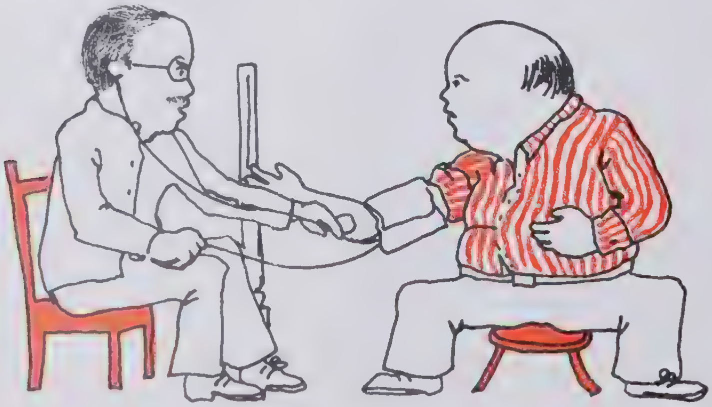
In this picture Philip Blaiberg does not have the heart he was born with. His own heart was too badly damaged to repair. A new heart from a man who had just died was transplanted to replace Blaiberg's. The transplanted heart kept Blaiberg alive for 19 months.

F. FAT FRANK

This man doesn't have heart trouble. But he has a good chance of getting it. He wasn't knifed in the heart. He doesn't have a birth defect. What is wrong with him?

He is overweight. He eats too much. He worries. He smokes like a furnace. He is like a lot of Americans.

The doctor is investigating Fat Frank's trouble. Frank has high blood pressure. The blood pounds through his body with such force that it may burst an artery.

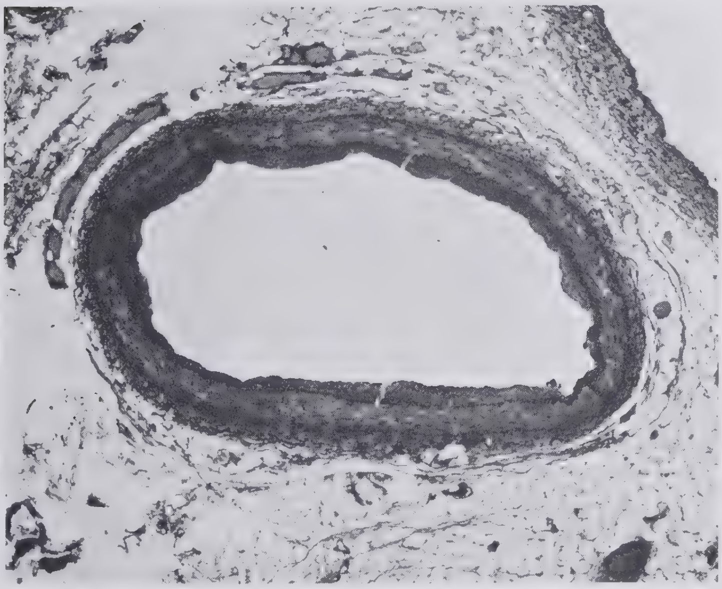


Nobody knows what actually causes high blood pressure. We do know, however, that sensible eating and sensible living help to prevent it.

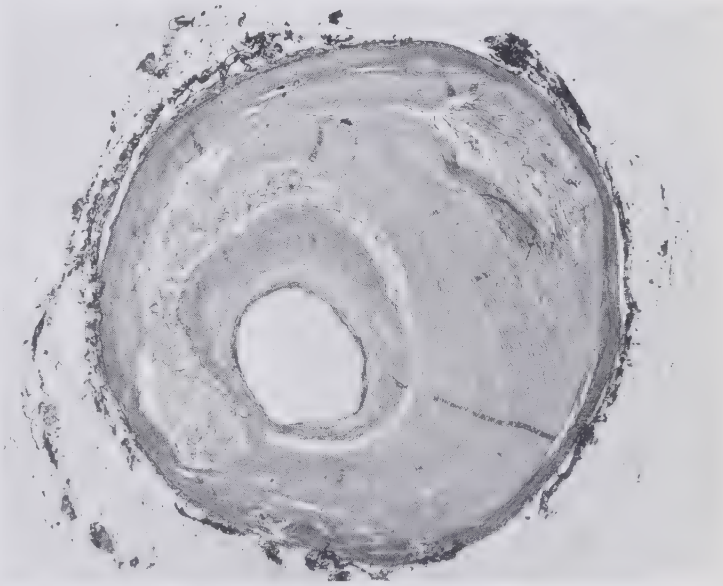
G. CLOGGED ARTERIES

This is a picture of 2 arteries. The left one is normal. The right one is blocked by deposits of **cholesterol** and calcium. These chemicals come from certain foods we eat.

The patient with the damaged artery ate a diet that was too rich and developed hardening of the arteries. This condition often goes along with high blood pressure.



AMERICAN HEART ASSOCIATION

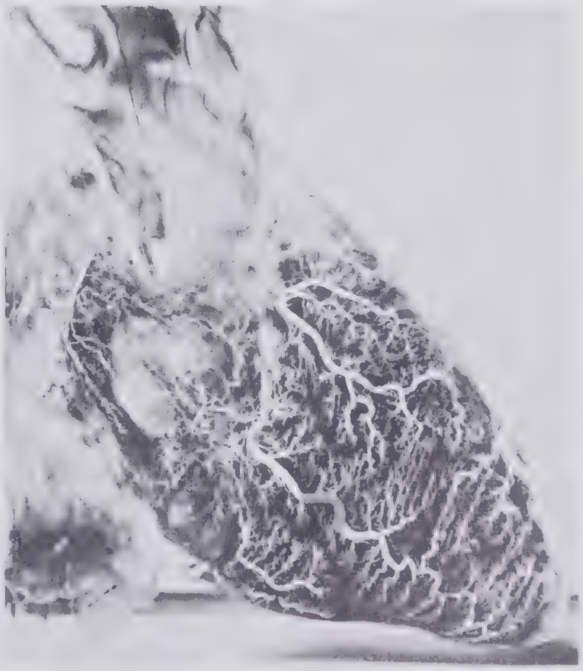


AMERICAN HEART ASSOCIATION

As the opening in the arteries becomes narrower, the blood pressure increases.

The cells of the heart need food just as other body cells need it. **Coronary** arteries carry blood to the heart tissues.

A block in the coronary arteries can be more serious than in most other places in the body. It causes heart attacks. Can you find the blocked artery in the picture?



O.V. BASTON, UNIVERSITY OF PENNSYLVANIA

H. THE KILLERS

Your heart is strong. It needs to stay strong. Nourish it with good food, but don't overeat. Stay thin. Exercise regularly to keep the heart from getting flabby.

More Americans die from heart and circulatory diseases than from any other cause. This is because they do not take proper care of themselves. Look at the table below.

PRINCIPAL CAUSES OF DEATH IN THE U.S. IN 1900 AND 1973

Rank	1900	1973
1	Influenza and pneumonia	Heart and circulatory disease
2	Tuberculosis	Cancer
3	Digestive system infections	Accidents
4	Heart and circulatory disease	Lung diseases (influenza and pneumonia)

I. HEART DISCUSSION

People are interested in the heart and in heart disease. Here are some questions that people ask. What do you and your group think about them?

1. Some people oppose heart transplants. They feel that a dead person's body should not be disturbed to give somebody else another few years of life. What do you think?
2. When a heart transplant operation is performed, the person giving the heart cannot be dead for very long. Otherwise the transplant won't "take." Doctors have to decide when a person is dead. Is it when the brain stops working? Is it when the heart stops beating? What do you think?
3. Because smoking is dangerous to one's health, cigarette ads no longer appear on TV. Should cigarette labels tell more than they do about this danger?
4. Open heart surgery is very expensive. It takes a whole team of doctors, nurses, and technicians. Some people think the money could be spent better in other ways. What do you think?
5. How has heart disease changed as a cause of death since 1900?
6. How else have the causes of death changed since 1900?
7. Can you explain the increase in death from accidents?

9 THE CIRCULATION GAME

Your circulation is a kind of plumbing system. It has 160,000 kilometers (100,000 miles) of piping. The pipes are the arteries, capillaries, and veins that carry the blood.

The blood brings needed supplies to all parts of the body. It carries away the wastes from the cells. It does other jobs, too, like keeping you warm, fighting germs, and stopping up breaks in your skin.

The heart does a good job of pumping the blood through the system. In 10 seconds it sends the blood to the lungs and back to the heart. In less than a minute it sends blood to the legs and back again to the heart.

As you play the Circulation Game, you will follow the blood on its journey around the body. To prepare for the game, make a deck of 42 cards. Write each of the terms below on 2 cards.

right atrium
right ventricle
left atrium
left ventricle
artery to lung
lung capillaries
vein from lung
main artery to body
artery to head
capillaries of head
vein from head
artery to lower body
artery to stomach
capillaries of stomach
vein from stomach to liver
capillaries of liver
vein from liver
branch artery in lower body
capillaries of lower body
vein from lower body
main vein from body

One player serves as banker. The banker writes out "credit slips," and issues the following to each player:

2 slips marked "100"
3 slips marked "50"
3 slips marked "20"
6 slips marked "10"
6 slips marked "5"
Total credits 500

Here are the rules:

1. The Chart of Circulation is the board. Each label is a station. Rice grains or any small objects may be used as markers.
2. Two, 3, or 4 may play.
3. Choose for deal. The dealer shuffles the cards and places the pack face down. Starting at the dealer's left, each player in turn cuts the pack, then places a marker on the station that turns up. This is his or her starting station.
4. Write down all starting stations. Two markers may be on the same starting station.
5. The dealer shuffles the cards again, deals 3 cards to each player, and leaves the rest of the pack face down.
6. Players leave their cards face up.
7. Each player in turn removes the top card from the pack. The player moves his or her marker if the card names a new station, then places the card face up on the discard pile.
8. Markers move with the arrows in the same direction as the blood. Where the circulation branches, a player may take either branch.
9. A player who cannot move may
   a. discard the card, or
   b. keep the card and discard another from his or her hand, or
   c. sell any card to the highest bidder.
10. Instead of drawing a card when his or her turn comes, a player may bid for any card in another player's hand.
11. When the pack is used up, shuffle the discard pile, place it face down, and continue.
12. The game ends when one player returns to the starting station. For finishing first, the player collects 100 credits from each of the others.
13. The winner is the player who has the most credits.

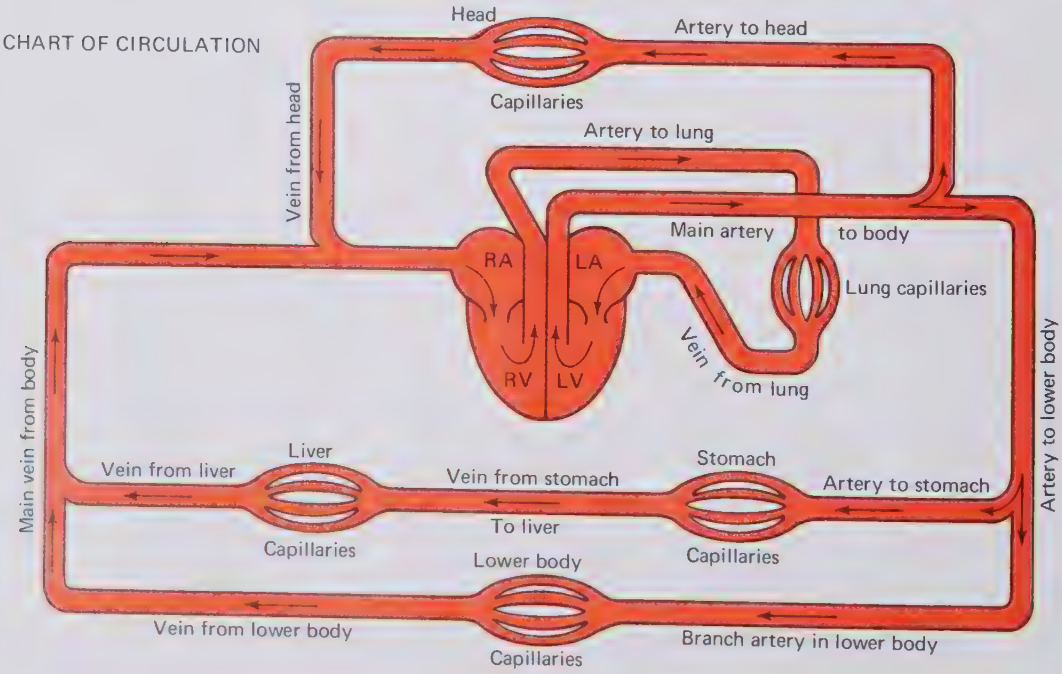
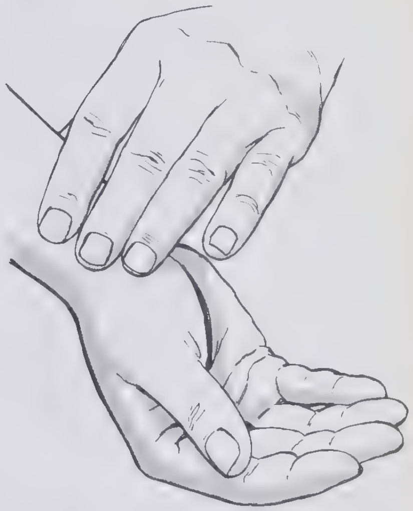


CHART OF CIRCULATION

10

YOU’VE GOT RHYTHM



A doctor who examines you may take your pulse. By doing this, the doctor is finding out how well your heart is doing.

A. TAKING YOUR PULSE

Take your own pulse as the picture shows. Use your middle finger. Find the beating artery in your wrist. Then with your finger press the artery against the wristbone.

Count the beat for one minute. Or, count the beat for 30 seconds and multiply by 2. (You can also switch with a neighbor and take each other’s pulse.) The count is your normal pulse. Copy the PULSE WORKSHEET and record your normal pulse.

Pulse Worksheet

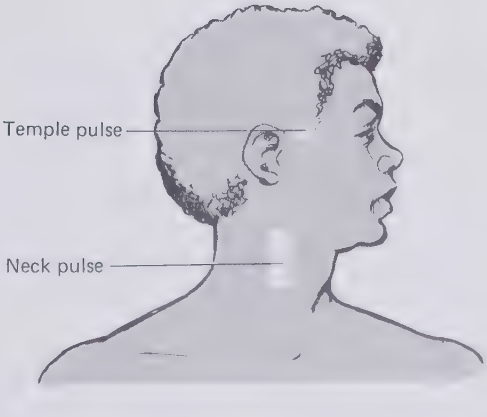
YOUR PULSE RECORD

Normal pulse	______	After exercise pulse rates:	
Temple pulse	______	Immediately after exercise	______
Neck pulse	______	After 2 minutes	______
Resting pulse	______	After 4 minutes	______
Standing pulse	______	After 6 minutes	______
After breathing pulse	______	After 8 minutes	______

1. Why do you multiply the 30-second count by 2?
2. Compare your normal pulse with your heart rate that you counted in an earlier chapter.
3. What do you think causes the pulse?

B. WHAT IS THE PULSE?

When the heart beats, it rhythmically pushes blood into the arteries. You feel this beat as the pulse.



You can take a pulse in any artery close to the skin that can be pressed against a bone or a hard cartilage. Try taking the 2 additional pulses shown in the picture. Record your results.

4. Compare the temple, neck, and wrist pulses. Explain your result.

C. CHANGING YOUR PULSE

What conditions cause your pulse to change? Some experiments will help you to find the answer to this question. Record all results.

Lie down and rest quietly for 2 minutes. Then take the "resting pulse."

Stand at attention for 2 minutes. Take the "standing pulse."

Breathe deeply for 30 seconds. Then take your "after breathing pulse." Record your results. Rest for 2 minutes before the next experiment.

Exercise until you are tired. Take your pulse immediately after exercising. Then take it again after 2 minutes, 4 minutes, 6 minutes, and 8 minutes. Record your results.

EXTRA: Make a line graph of your pulse at these different times.

5. How long did it take for your pulse to return to normal after exercise?

D. PULSE RATES OF DIFFERENT PEOPLE

Using the numbers in the table, figure the average pulse for girls, girl athletes, boys, and boy athletes. To get the average for each list, add the list, then divide by the number of pulses on the list.

PULSE RATES OF DIFFERENT PEOPLE

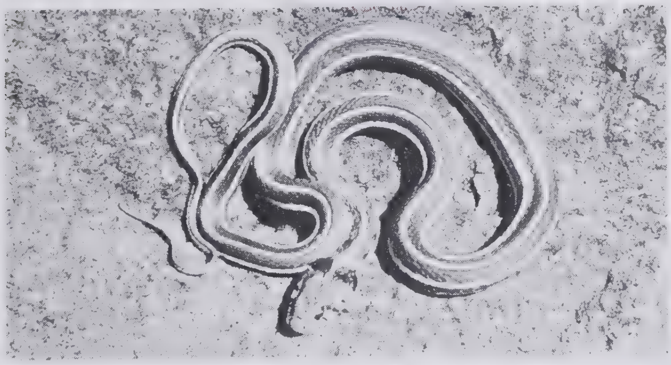
	Girls	Girl Athletes	Boys	Boy Athletes
	83	70	77	70
	76	65	74	72
	87	83	83	60
	88	78	88	68
	78	72	67	74
	79	71	70	69
	88	80	80	71
	84	69	80	67
	73	74	76	70
	69	79	72	68
AVERAGE				

6. Does one's sex make a difference in the pulse rate?
7. What kind of pulse rate are athletes likely to have?

11 COOLING IT

word guide
evaporate
i-VAP-uh-rayt

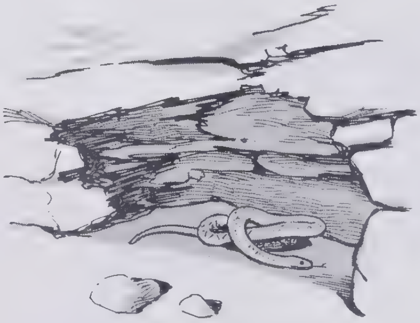
This garter snake is sunning itself on a warm rock.


WESTERN WAYS FEATURES

Most snakes are harmless. You can learn to handle them.

If you lifted the snake from the rock, it would feel warm.

A. THE COOL SNAKE



The same snake has crawled into a cold cave. The snake would now feel cool to your touch.

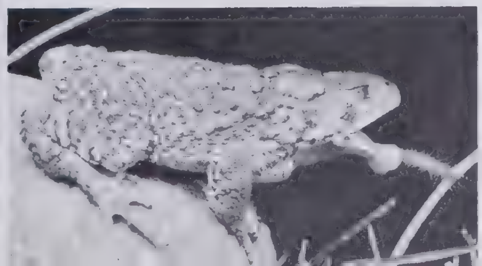
You could easily catch the cold snake in the cave. When the snake's body is cold, it doesn't have the energy to move very fast.

1. Snakes change their body temperature according to the temperature of the ______.

Many animals change their body temperature just as a snake does.

USDA PHOTO

COURTESY AMERICAN MUSEUM OF NATURAL HISTORY


COURTESY HENRY D. KANE

COURTESY CAROLINA BIOLOGICAL SUPPLY COMPANY

ELWIN R. SANBORN, N.Y. ZOOLOGICAL SOCIETY

B. ARE YOU COOL TOO?

Does your body temperature change as it gets warmer or cooler outside? Take your temperature and find out.

TEMPERATURE ACTIVITY

A

Before and after each use, sterilize thermometer with alcohol. Don't use hot water.

B

Shake it down after each use. Keep fingers off the bulb. Don't hit people or furniture.

C

The teacher will help you learn to read the thermometer.

D

Sit down. Take your temperature by holding thermometer under your tongue for 3 minutes.

TEMPERATURE CHART

	Temperature		
Initials of Student	At Rest	While Warm	While Cool

E

Copy this chart in your notebook and record your temperature in the "At Rest" column.

F

Exercise until you feel hot, or warm yourself some other way.

G

Take your temperature again. Record it.

H

Relax. Cool off. Take your temperature again and record it.

I

Make a class chart on the board. Study the board chart.

2. What is the normal temperature of the body?

3. How is human control of body temperature different from a snake's?

J

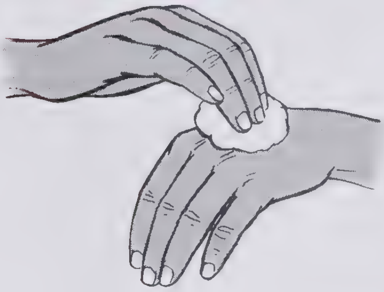
Rub some water on the back of one hand. Watch the water disappear or **evaporate.**

K

Quickly rub some alcohol on the back of the other hand.

4. Which hand feels cooler?

5. Did water or alcohol cool you off more?



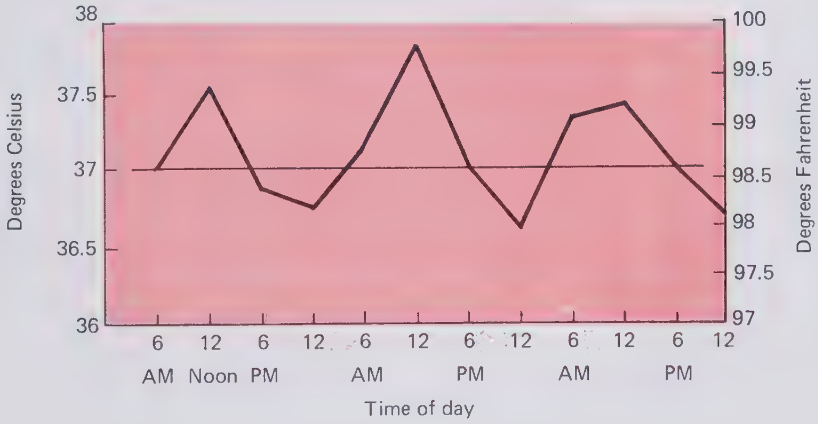
6. What happened to the water and alcohol?

7. Which worked faster?

8. The process that cools us off is called ____.

C. UP AND DOWN

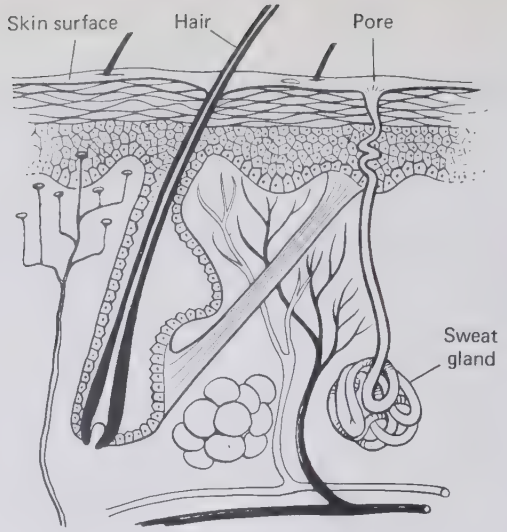
A person's temperature rises and falls slightly throughout the day. This graph shows the temperature of a normal healthy person taken over several days.



9. When during the day is body temperature highest? Lowest? Explain why you think it changes.
10. What are the highest and lowest temperatures in degrees Celsius? In degrees Fahrenheit?
11. What is the normal Celsius body temperature? The normal Fahrenheit body temperature?

D. COOLING IT

You saw that evaporation of liquids can cool you. When you are hot, you perspire. The sweat evaporates and carries off some body heat. This cools you.



E. THE BUSY SKIN

The skin is a jack-of-all-trades.

Here are some of its jobs:

I'm safe in here.

It protects the inside of the body.

I give up! We can't get through here.

It keeps out germs.

It keeps the body from drying out.

Wow! Thats cold!

It feels things.

I need a shower after that workout!

It gets rid of wastes.

That feels good!

It cools you.

F. SWEAT GLANDS

There are many tiny sweat glands in the skin. By pouring out sweat, the glands do 2 of the skin's many jobs.

12. Can you name the 2 jobs that sweat glands do for you?

You can watch the sweat glands at work.

Place your hand and forearm in a large plastic bag for a few minutes. Close it with a loose rubber band or string.

13. What do you see happening? You can answer this question in words or with a drawing.

Remove the plastic bag and turn it inside out.

12 BREATHING IN AND OUT

How long can you go without eating? Two days? A week?

A record was set by Terence MacSwiney, an Irish mayor. On a hunger strike, he went 74 days before dying of starvation.

How about drinking? You can live for maybe a week without water.

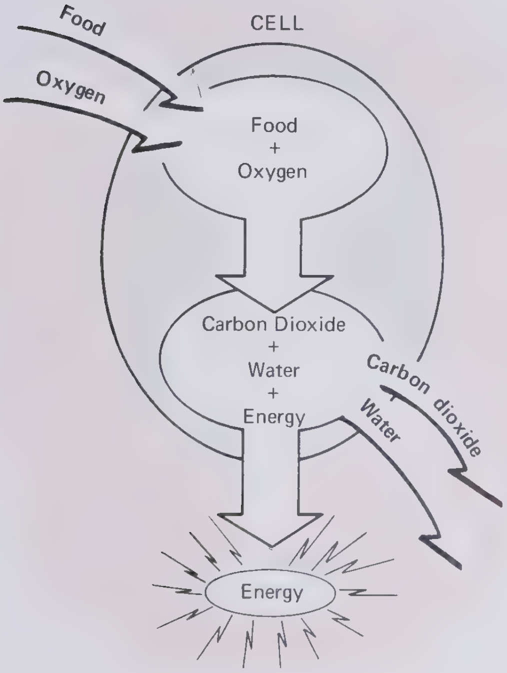
UPI PHOTO

word guide

diaphragm
DY-uh-fram
inhalation therapist
in-huh-LAY-shuhn THER-uh-pist
respiratory
RES-puhr-uh-tor-ee

A. BUT YOU HAVE TO BREATHE

You can live only about 20 minutes without breathing. Long before that you will be unconscious and your brain will be damaged.



Air is very important to us. We use oxygen in the air to burn food in our cells. This gives us energy.

Burning produces carbon dioxide, which we breathe out.

B. SNORKELS AND SPACE SUITS

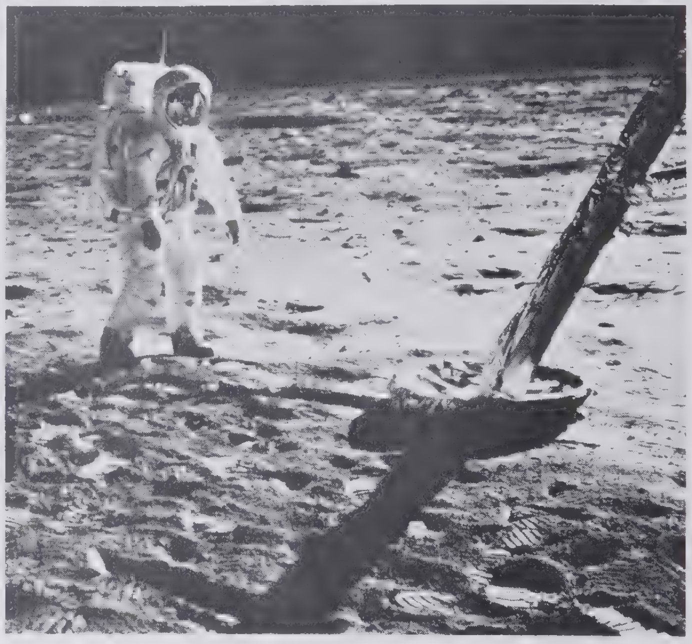
People are interested in special breathing equipment. You have probably seen the snorkels and undersea breathing apparatus that scuba divers use.

PAUL TZIMOULIS

Pressurized cabins and oxygen masks in airplanes are also special breathing equipment. These are used at high altitudes where there is less air.

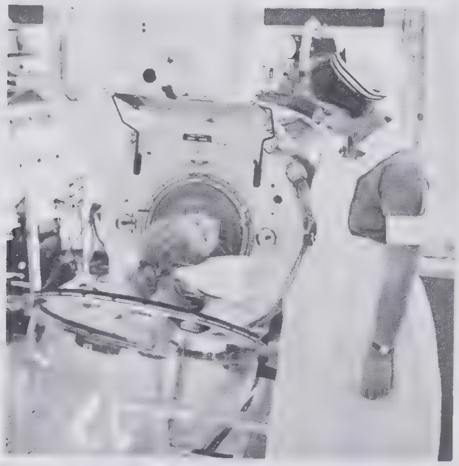
PAN AMERICAN WORLD AIRWAYS PHOTO

Stewardess Nelida Perez demonstrates airplane oxygen mask.


NASA

Astronaut Buzz Aldrin on the moon

Space suits are used on the moon, where there is no air.


THE CHILDREN'S HOSPITAL MEDICAL CENTER, BOSTON

Iron lungs are special devices for people whose breathing muscles are paralyzed.

FREEDMEN'S HOSPITAL, WASHINGTON, D.C.

Inhalation therapists or technicians use special equipment in hospitals to help people with breathing problems.

Of course all of these devices only help our natural breathing or **respiratory** system. You can learn how this system works by dissecting the breathing system of a cow or sheep. Their systems closely resemble ours. Do the RESPIRATORY SYSTEM WORKSHEET.

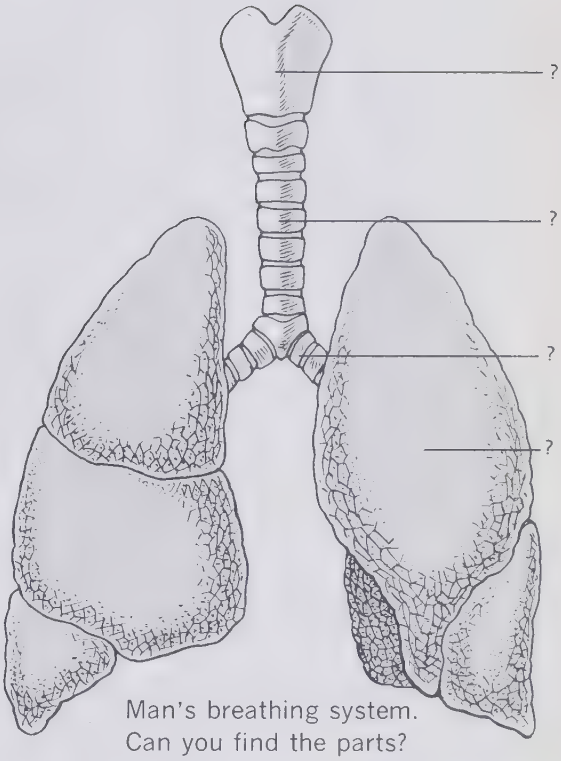
RESPIRATORY SYSTEM WORKSHEET

A. Spread out the cow or sheep lungs on the table.

1. Lift the lungs. Are they light or heavy?
2. Do they feel smooth or rough?
3. What is their color?
4. Cut off a small piece and put it in water. What happens? Why?

B. Air has to reach the lungs. Try to figure out the path that the air follows. The questions will help you.

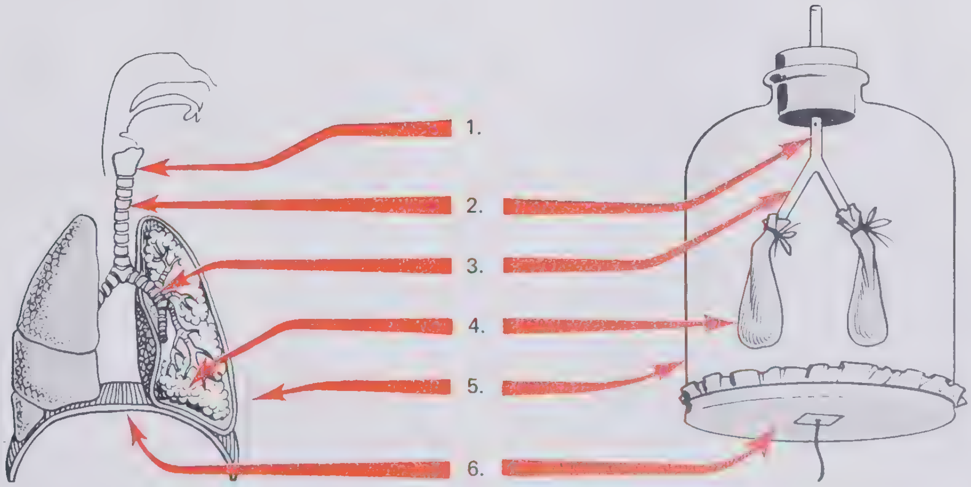
5. From the nose or mouth the air goes into the windpipe. Find it. What does it look like?
6. Feel the windpipe. How does it compare with the lungs? Explain the difference.
7. Find the voicebox. Where is it?
8. Where does the windpipe lead?



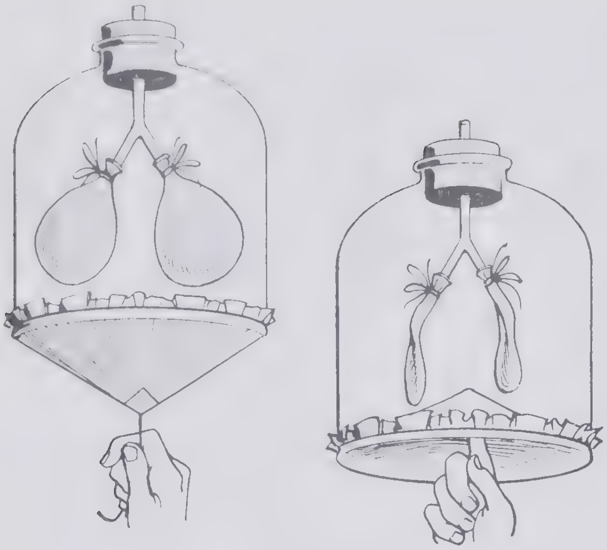
Man's breathing system.
Can you find the parts?

C. Lungs cannot breathe by themselves. Muscles make them breathe. The glass lung model will help you learn how you breathe.

9. Copy and label the diagram.
10. What do the balloons represent?
11. What do the glass tubes represent?
12. Put your hand on your chest and breathe. What part of the body does the glass jar represent?



13. Put your hands under your ribs and feel the **diaphragm** muscle. What part of the model represents the diaphragm?



D. Now make the model breathe.

14. Pull the model diaphragm down. What happens?

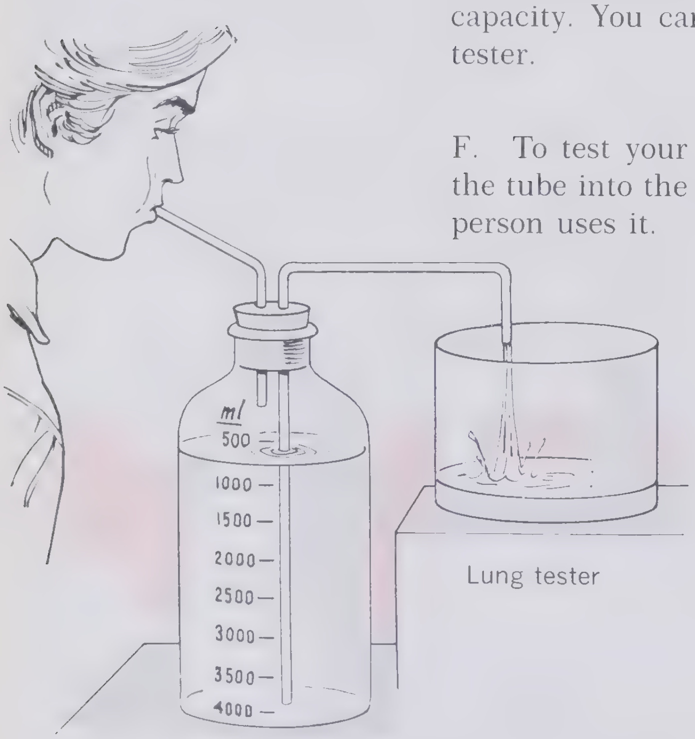
15. How does your diaphragm help you breathe in?

16. With the help of the model, figure out how your diaphragm helps you breathe out.

17. The model chest doesn't work. Can you explain what happens to your chest when you breathe in and out?

E. Swimmers, athletes, and singers have strong breathing muscles in the chest and diaphragm. Their training gives them a big lung capacity. You can measure your own lung capacity with the lung tester.

F. To test your lungs, first breathe in. Then breathe out through the tube into the bottle. Clean the mouthpiece before and after each person uses it.



Lung tester

18. Breathe out normally. How much air is there in your normal breath?

19. Breathe in deeply, and then breathe out as deeply as you can. What is your maximum lung capacity?

20. Your maximum lung capacity, compared to your standard, is a good test of your physical fitness. This is how you do the test:

For girls: Your height (in centimeters)	×	20	=	ml standard for your height
For boys: Your height (in centimeters)	×	23	=	ml standard for your height
EXAMPLE: 160 cm	×	20 (girls)	=	3,200 ml

21. How does your lung capacity compare to your standard?

13 POWER IN THE CELLS

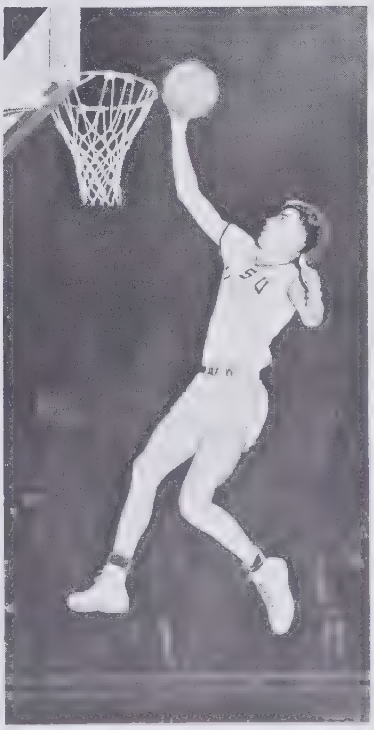
word guide

oxidation
ok-suh-DAY-shuhn
sodium
hydroxide
SOH-dee-uhm
hy-DROK-syd

Have you ever watched a blazing fire? The crackling flames lick at the wood. Burning fuel hisses and snaps. Heat pours out at you. There's lots of energy there!

Watch a powerful machine or a fast car roaring down the highway. There's lots of energy there, too!

Watch a good basketball player. The player spins, jumps, runs, passes, shoots, and reaches high for the ball. A lot of energy is being used.


WIDE WORLD PHOTOS, INC.

A. THE NAME OF THE GAME IS OXIDATION

Where does the basketball player get the energy? It comes from the same source as your energy. It is also the same source that supplies the fire, the machine, and the car.

In each case the energy comes from burning fuel. Because all burning needs oxygen, the process is called **oxidation.**

Your body burns food. It is burned in all the cells. Sugar, starch, and fat are the main fuel nutrients. This special kind of oxidation in the cells is called cell respiration.

Both burning and cell respiration are forms of oxidation. They are basically the same.

1. The table below compares 2 forms of oxidation. The last column has been left blank. Complete the last column in your notes.

CHARLES PFIZER AND CO., INC.

Measuring cell respiration

BURNING AND CELL RESPIRATION—RESEMBLANCES

Resemblances	Burning	Cell Respiration
What is burned	Fuel—wood, coal, oil, gasoline, etc.	
Gas used	Oxygen	
Gases produced	Carbon dioxide Water vapor	
Useful product	Energy	

B. CELL RESPIRATION

NATIONAL FIRE PROTECTION ASSOCIATION

Burning

There are no flames in your body. What is so special about the kind of burning that we call cell respiration?

It takes place in the cells of all living things. It is slow oxidation, at a low temperature, without a flame. Most important, it is oxidation under careful control. It never runs wild and burns you up. Instead your cells burn food, and release energy, at exactly the rate needed by your body.

2. The table below shows differences between burning and cell respiration. Complete the last column of the table in your notes.

BURNING AND CELL RESPIRATION—DIFFERENCES

Differences	Burning	Cell Respiration
Appearance	Flame	
Temperature	High	
Rate	Fast oxidation	
Control	Not easily controlled	

C. BUILT-IN CONTROL

When you get excited, run, exercise, or play hard, you need more energy. Sometimes you need the energy very quickly.

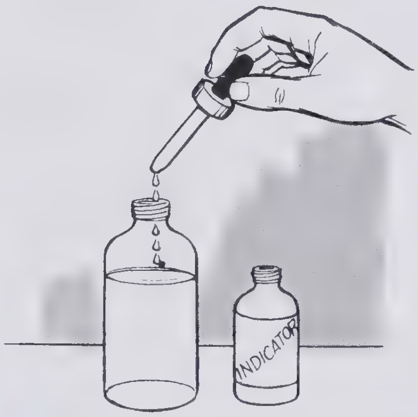
Your cells make the adjustment right away. They use more oxygen, burn more food, produce more carbon dioxide, and release more energy. When you don't need extra energy, cell respiration slows down.

You can easily check on these changes by measuring the amount of carbon dioxide produced. The CELL-RESPIRATION ACTIVITY shows you how to do this.

CELL-RESPIRATION ACTIVITY

A

Measure 100 ml of water into a bottle.

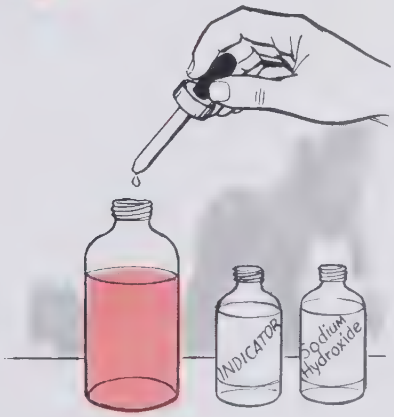


B

Add 5 drops of indicator. Stir. If the water stays colorless, that means there may be carbon dioxide (CO_2) in the water.

C

Get rid of the CO_2. Slowly add **sodium hydroxide,** drop by drop, stirring after each drop, until the solution turns light pink. Then the CO_2 is gone. How many drops did it take?



D

Keep this bottle as a control. You must match the pink color in your tests.

E

Measure 100 ml of water into another bottle. Add 5 drops of indicator. Stir.

F

Sit quietly for one minute. Then bubble your breath into the second bottle for 15 seconds.

G

Add sodium hydroxide, drop by drop, until you get the same pink color as in the control. Remember to stir after adding each drop. Count the drops.

MEASURING CARBON DIOXIDE

Step in Experiment	Number of Drops of Sodium Hydroxide Used
Control	
After sitting quietly	
After mild exercise	
After vigorous exercise	

H

Copy the table. Record the number of drops it took to get rid of the CO_2 in the control and from your breath while you were sitting still.

I

Wash out the bottle. Refill with fresh water and indicator.

J

Exercise mildly by walking for one minute.

K

Repeat CO_2 test. Record number of drops of sodium hydroxide used this time.

L

Again wash out and refill the bottle. Exercise more vigorously. Repeat CO_2 test and record result.

3. In which part of the experiment did you produce the most CO_2? The least?
4. Would you agree that the more we exercise, the more CO_2 we produce?
5. As we use more energy, what happens to the rate of cell respiration?
6. As cell respiration increases, the cells need more ____ and more ____.
7. What was the purpose of the control in the experiment?

14 THE BODY BALANCER

This is New York City during a garbage strike. Garbage spreads disease. How do you think the people liked living with piled up wastes?

DEPT. OF SANITATION, CITY OF NEW YORK

word guide

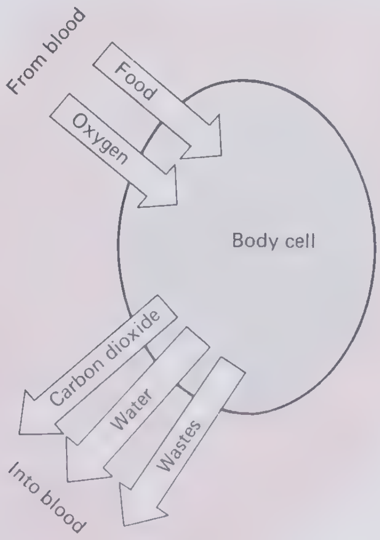
albumin	*al-BYOO-min*
diabetes	*dy-uh-BEE-tis*
urethra	*yoo-REE-thruh*
urinalysis	*yoor-uh-NAL-uh-sis*
urine	*YOOR-in*

A. BODY WASTES

Cells at work in the body produce wastes, too.

When cells die or are damaged, their broken down parts also go into the blood. So do excess foods, such as sugar, that cannot be used by the cells.

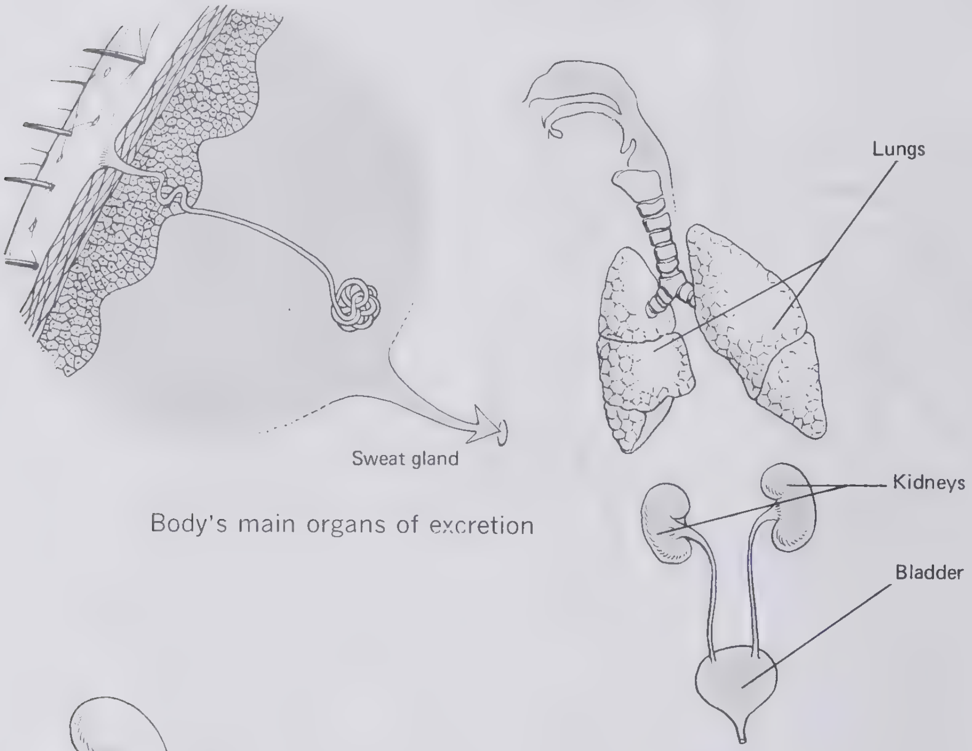
If all these wastes stayed in the blood, they would poison the cells. But they don't stay there.



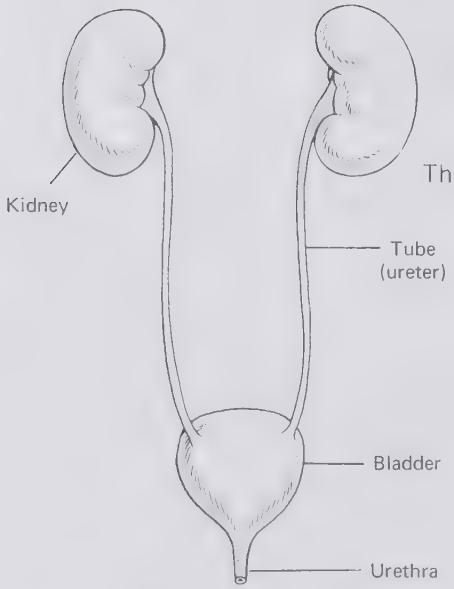
The lungs breathe out waste carbon dioxide.

Undigested food never gets near most of the cells. It is eliminated through the rectum.

Sweat glands also get rid of some wastes.



Body's main organs of excretion



The kidneys and their connections

B. KIDNEYS DO THE BIG JOB

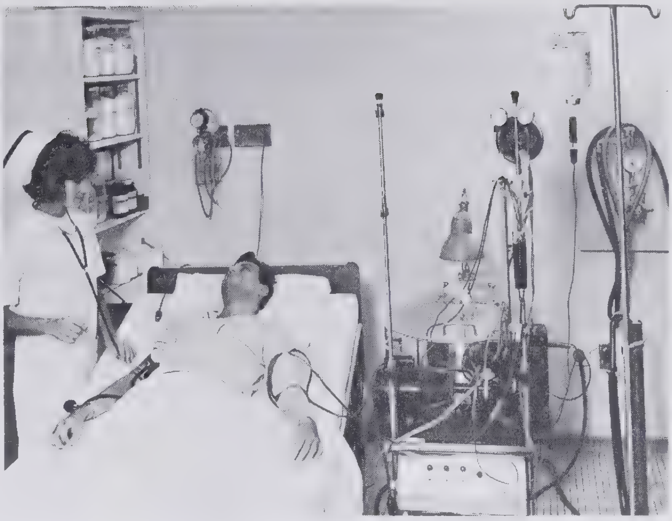
Most waste material dissolved in the blood is cleaned out by the kidneys. They excrete it in **urine.**

You have 2 kidneys, located near the middle of the back. Each sends its urine down a tube into the bladder. The bladder empties through another tube, the **urethra.**

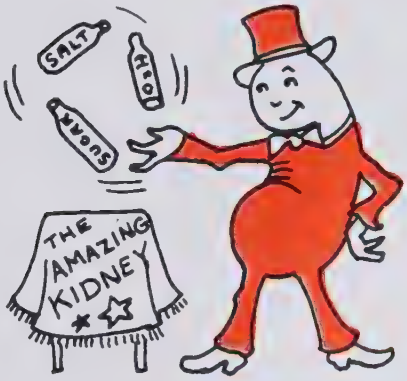
1. Can you name 4 ways that wastes leave the body?
2. After a heavy blow to the kidneys, blood sometimes appears in the urine. Why?

The kidneys do more than filter wastes out of the blood. They also help the blood retain useful chemicals. Thus they help keep all the body's chemicals in balance.

When a person's kidneys break down, an artificial kidney can do their job. The patient's blood flows into the machine. The blood is then filtered and brought into proper balance. It is then pumped back into the patient. Water, sugar, and salt are some of the chemicals that the kidneys keep in balance.


PETER BENT BRIGHAM HOSPITAL

Artificial kidney



A person ill with **diabetes** cannot burn enough sugar in his or her cells. The excess sugar stays in the blood. The kidneys spill some of the excess sugar into the urine.

C. TESTING URINE

Years ago doctors detected diabetes by tasting the urine. Today diabetes can be detected by examining either the blood or the urine for sugar.

3. What did the doctor taste in the urine if the person had diabetes?
4. How is diabetes detected nowadays?

A lab assistant tests urine for sugar. He or she also tests for **albumin,** a protein. Albumin is useful when it is in the blood. When it appears in the urine, however, it may mean that the kidneys aren't working properly.

ST. FRANCIS HOSPITAL, WICHITA, KANSAS

Urine test

The lab assistant does many other urine tests to help the doctor.

You can learn to do a **urinalysis.** First answer the questions below. Then tackle the PRACTICE-URINALYSIS ACTIVITY.

5. What is a urinalysis?
6. Doctors say: "Urine reflects the health of the person." What do they mean?
7. List all the places that cellular wastes pass through. Three answers are already given.

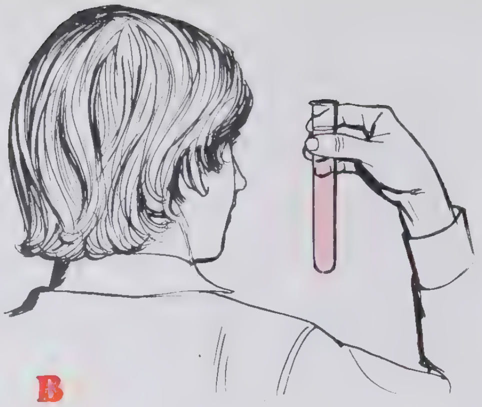
(a) cells (c) kidney (e) (g) excreted urine

(b) (d) (f)

PRACTICE-URINALYSIS ACTIVITY

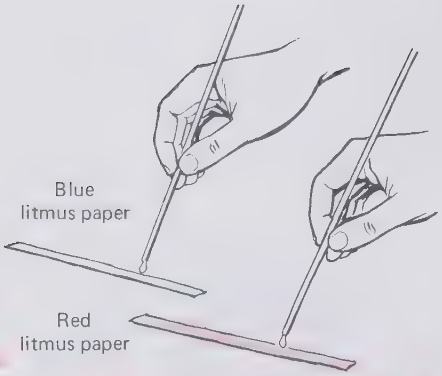
A

Get a sample of "practice" urine and copy the URINALYSIS WORKSHEET in your notes.



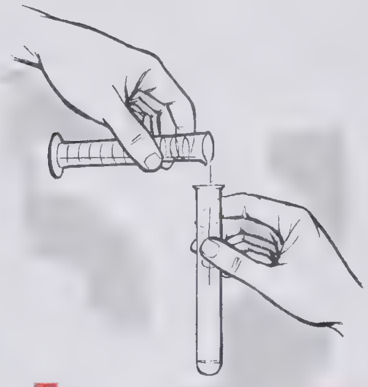
B

Note the color of the "practice" urine. Check it off in PRACTICE URINE column on URINALYSIS WORKSHEET.



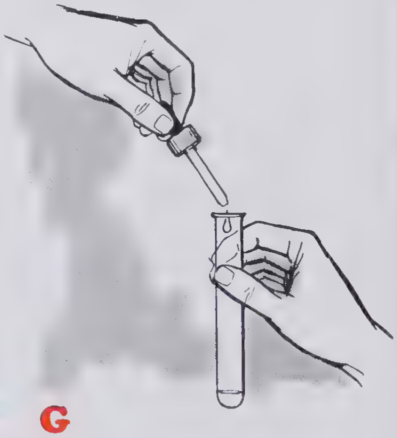
E

Test with pH paper.
Blue turns red = acid.
Red turns blue = basic.
Red stays red } = neutral.
Blue stays blue }



F

To test for sugar, pour 5 ml of Benedict's reagent into a test tube.



G

Add 8 drops of urine.

J

Color reaction tells how much glucose sugar is present.

BENEDICT TEST FOR SUGAR

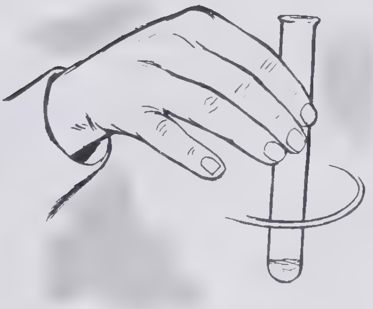
Color	Amount of Sugar	
Blue		none
Green	+	trace
Green-yellow	+ +	moderate
Yellow	+ + +	medium
Orange-red	+ + + +	heavy

C

Check off the appearance. Girls' urine is generally cloudier than boys'.

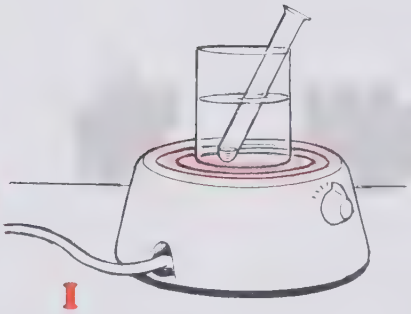
D

Check off the odor.



H

Mix well.

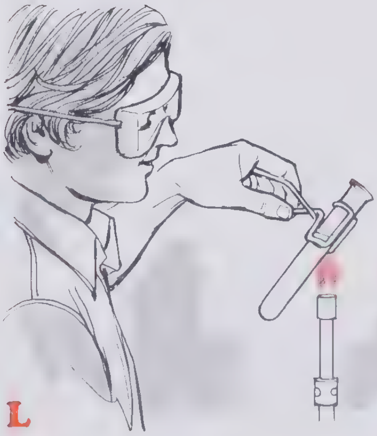


I

Heat in boiling water for 5 minutes.

K

To test for albumin, fill test tube $\frac{2}{3}$ full of urine.



L

Boil upper part of tube for one minute.
CAUTION: Wear glasses or goggles. Point mouth of tube away from people.

M

If clear, there is no albumin.

N

If cloudy, add 3 drops of acetic acid.

O

If cloudiness remains, albumin is present.

P

Record all results of "practice" urine.

Q

Obtain a mystery sample of practice urine. Find out what's in it. Repeat all tests. Record results.

URINALYSIS WORKSHEET

COPY THIS WORKSHEET IN YOUR NOTES.

Test	Results to Look For	Practice Urine	Mystery Practice Urine
COLOR	Light yellow Medium yellow Dark yellow		
APPEARANCE	Clear Cloudy		
ODOR	Like urine Some other odor		
pH	Acid Basic Neutral		
SUGAR	Blue None Green + Green-yellow + + Yellow + + + Orange-red + + + +		
ALBUMIN	None Present		

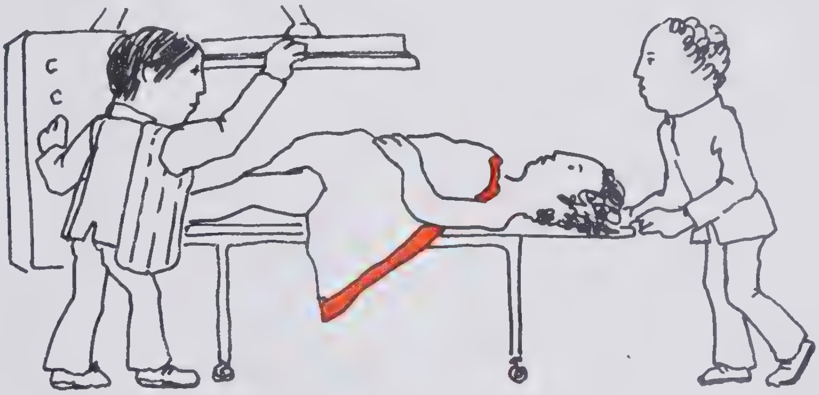
15

JOBS IN THE HEALTH FIELD

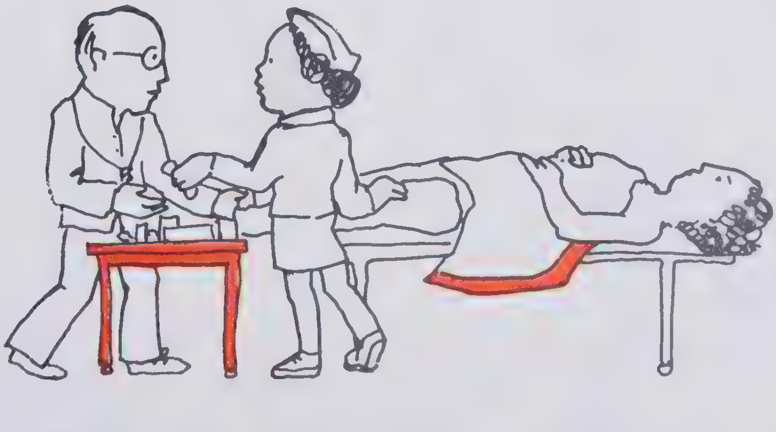
word guide

dietitian	*dy-uh-TISH-uhn*
hygienist	*hy-JEN-ist*
optometrist	*op-TOM-uh-trist*
orthopedic	*or-thuh-PEE-dik*
orthoptist	*awr-THOP-tist*
pharmacist	*FAHR-muh-sist*
physician	*fuh-ZISH-uhn*
physiotherapist	*fiz-ee-oh-THER-uh-pist*
psychologist	*sy-KOL-uh-jist*
technologist	*tek-NOL-uh-jist*

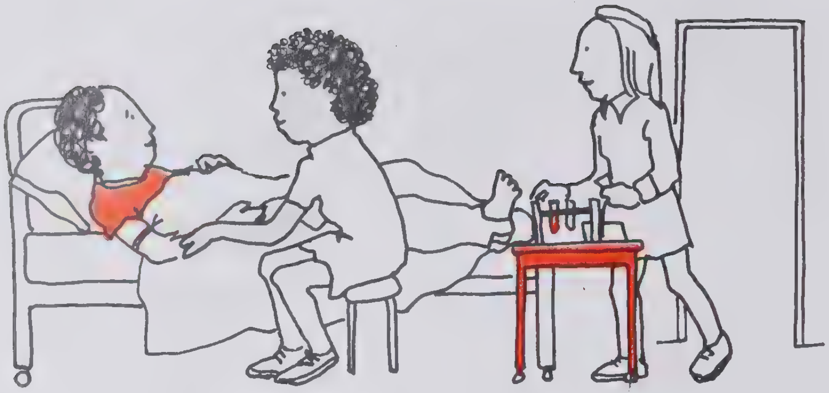
Mrs. Romano fell on the ice and broke her leg. The driver and assistant give first aid and put her into the ambulance.



The doctor has ordered X-rays. The orderly delivers the patient to the X-ray technician. X-rays will show the details of the break.



The nurse helps the doctor set Mrs. Romano's leg.



The lab technician draws blood for tests. The practical nurse (LPN) stands by with the medicine.

The food service worker has just brought dinner. With her leg in a cast, Mrs. Romano cannot move very well. The nurse's aide helps her eat.

Mrs. Romano is recovering, but will need crutches for a while. The **physiotherapist** helps her get used to them.

A. HEALTH CAREERS

By the time Mrs. Romano left the hospital, 25 different health workers had looked after her. Many others whom she never saw also helped her.

Some of the health workers were highly trained professionals. The nurse or RN, the **pharmacist,** and the physiotherapist had gone to college. The doctor or **physician,** the **dietitian,** and the medical social worker had studied even beyond college.

Other health workers were high school graduates who had taken special training. These included the practical nurses, the cooks, and the technicians.

Still others went to work right after high school, or even without finishing high school. These included nurses' aides, ward clerks, secretaries, housekeepers, and maintenance workers.

MARION BERNSTEIN, EDITORIAL PHOTOCOLOR ARCHIVES

Nurse with patient

CARY S. WOLINSKY, STOCK, BOSTON

Medical record librarians must be trained.

B. A JOB FOR YOU

The time is near when you will go to work. What will you be? What will you do?

Do you like to help people? A health career may be your thing.

Today there are 4 million people in health jobs. The number is growing. One in 10 of your classmates will probably be a health worker.

This field needs people with all levels of education and training. The pay range is from $4,000 to over $80,000 a year. In some jobs you can start low and work up.

Suppose you enjoy lab work, like testing blood and urine, and identifying germs.

With a high school diploma and one year's hospital training, you can become a certified lab assistant. With 2 years of college, you can qualify to be a medical lab technician. The highest grade, medical **technologist,** requires a college degree.

Medical lab technicians

C. WHAT ARE THE JOBS?

The table below shows some of the main health jobs. The table also lists a school interest related to each job, and the kind of work involved.

Numbers indicate the training required.
1 means high school graduation or less.
2 means high school graduation plus special training.
3 means college graduation.
4 means college graduation plus additional study.

HEALTH CAREERS TABLE

School Interest	Health Career	Training	Kind of Work
Art	Occupational therapist	3	Teaches crafts to help in patients' recovery
Business	Administrator	4	Manages hospital
	Secretary	2	Office work; takes doctor's dictation
	Ward clerk	1	Keeps records
	Dental assistant	3	Helps dentist
Languages	Translator	3	Translates for patients who speak no English
	Speech and hearing therapist	3	Trains patients with speech and hearing difficulties
English	Medical record librarian	4	Keeps medical records
Home economics	Registered nurse (RN)	3	Care for patients
	Practical nurse (LPN)	2	
	Nurse's aide	1	
	Cook	2	Prepare and serve meals
	Food service worker	1	
	Dietitian	4	Supervises food service; teaches patients

HEALTH CAREERS TABLE (Continued)

School Interest	Health Career	Training	Kind of Work
Home economics (cont.)	Housekeeper	1	Keeps hospital clean
	Home health aide	1	Helps patients in their homes
Physical education	Physiotherapist	3	Gives exercise to help in patients' recovery
Industrial arts	Engineer	3	Maintain hospital buildings and equipment
	Maintenance person	1	
	Ambulance driver	2	Drives ambulance; gives first aid
	X-ray technician	3	Operates X-ray machines
	Inhalation therapist	3	Operates oxygen equipment
	Orthopedic technician	2	Builds braces
Music	Recreational therapist	3	Plans recreation to help in patients' recovery
Social studies	Medical social worker	4	Helps patients with personal and family problems
	Psychologist	4	Studies patients; helps with personal problems
	Orderly	2	Helps patients in hospital
Science	Physician or doctor	4	Treats patients; directs other health workers
	Dentist	4	Treats teeth
	Pharmacist	3	Prepares and gives out drugs and medicines
	Optometrist	3	Makes eyeglasses
	Medical technologist	3	Do lab tests
	Medical laboratory technician	2	
	Certified laboratory assistant	1	
	Dental **hygienist**	2	Cleans teeth; instructs patients in proper dental care
	Orthoptist	3	Trains patients with eye problems

HEALTH-CAREERS ACTIVITY

A

Find health career listings in the newspaper classified ad section. Read the ads for 2 jobs that interest you. For each job, list this information:

1. Where is the job?
2. What are the requirements?
3. What work would you do?
4. What is the pay?
5. What other benefits are there?

B

Students over 16 can work as volunteers in a hospital. Find out from a hospital, a health worker, or some other source, what these volunteers do.

FOOD

CONTENTS

FOOD

1 Why Eat? (3) 67
2 Vitamins (9) 73
3 What's So Great about Milk? (13) 77
4 The Cow in the Kitchen (17) 81
5 Science in the Kitchen (21) 85
6 Counting Calories (25) 89
7 Your Right Weight (29) 93
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9 Believe It or Not about Food (37) 101
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11 The Hungry Food Tube (43) 107
12 Just Passing Through (47) 111
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14 Jobs with Food (55) 119
15 Read the Label (59) 123

1 WHY EAT?

Why do you eat?

First, you eat because you are hungry.

Second, you eat because you like to eat. You have an appetite for food.

Third, eating is a social thing. When you go visiting, the host or hostess often serves a bite to eat. When you go out with the gang, you like to drop in for pizza, hamburger, or a shake.

word guide

Benedict	*BEN-uh-dikt*
biuret	*by-yuh-RET*
carbohydrate	*kahr-buh-HY-drayt*
chemical	*KEM-i-kuhl*
iodine	*Y-uh-dyn*
nitrate	*NY-trayt*
nutrient	*NOO-tree-uhnt*
protein	*PROH-teein*
vitamin	*VY-tuh-min*

W. B. FINCH

OHIO DEPT. OF DEVELOPMENT

STOCK, BOSTON

These are 3 good reasons for eating.

Actually there are 3 better reasons. You must have food to keep going. Hunger and appetite are nature's way of coaxing you to eat the food that your body needs.

A. WHAT IS A PERSON WORTH?

Like every object in the world, your body is made of **chemicals.** Suppose you went out to buy these chemicals. Even at today's high prices you wouldn't spend very much.

Of course a person is worth far more than just the cost of his or her body chemicals. Every individual is precious as a human being.

Yet the chemicals of the body wear out. They must be replaced.

Eating supplies the spare parts. The first reason for eating then is to replace used up chemicals in the body.

B. THE LIVING ENGINE

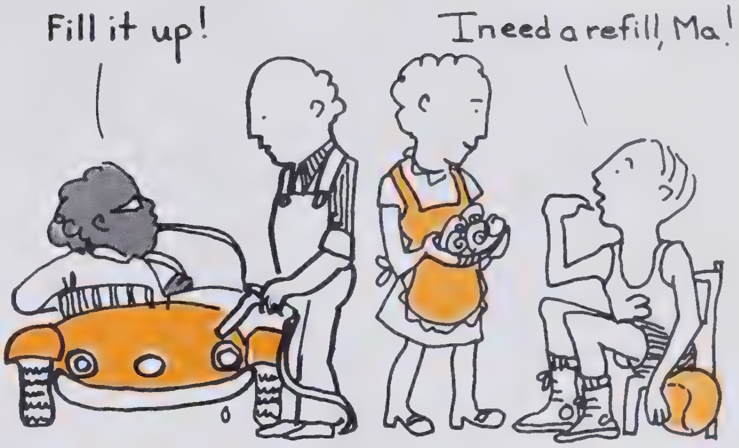
Nobody just sits around like a bunch of chemicals in a bottle. Let's look at 2 more reasons for eating.

People keep on the move. They go. They breathe. They turn on the heat. All this takes energy.

STOCK, BOSTON

To keep a car running, you stop at the gas station and fill the tank. Gasoline burns in the engine. Burning gas gives the car energy.

To keep yourself active, you take in food. Your body burns the food and you get energy from it. Getting energy is the second reason for eating.


Fill it up!
I need a refill, Ma!

Every once in a while a car needs a tuneup. The engine has to be tuned up or regulated.

The body also has to be regulated. Food contains chemicals that do the regulating. Getting these regulating chemicals is the third reason for eating.

C. THE NUTRIENTS

In food there are 6 kinds of useful chemicals. They are called **nutrients.** Anything that is a food must contain nutrients. The 6 kinds of nutrients are:

carbohydrates minerals **vitamins**
fats **proteins** water.

This is how the nutrients divide up the 3 jobs your body requires:

WHAT NUTRIENTS DO

Job	Nutrients
Supply energy	Carbohydrates (sugar and starch) Fats
Supply chemical spare parts	Proteins Minerals
Regulate the body	Minerals Vitamins Water

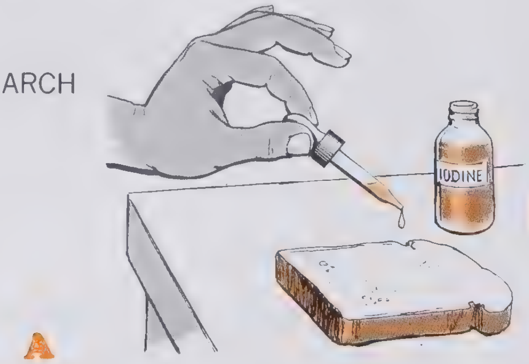
1. What are 3 reasons for eating?
2. What group of nutrients does 2 jobs in the body?

What foods contain which nutrients? The NUTRIENT ACTIVITY shows you how we find out.

Copy the NUTRIENT WORKSHEET shown on page (8) 72. Then do the NUTRIENT ACTIVITY and record all the results on the worksheet.

NUTRIENT ACTIVITY

TEST FOR STARCH



Starch is a carbohydrate. Use **iodine** to test for starch in bread.

3. What color reaction tells you that starch is present?

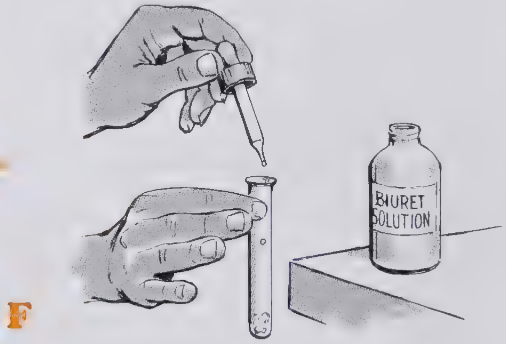
B

Record all results on your NUTRIENT WORKSHEET.

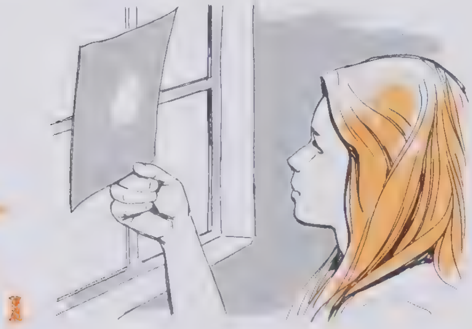
Look for green, yellow, orange, or red color. Record result.

4. Why do you think this test for simple sugar gives different colors?

TEST FOR PROTEIN



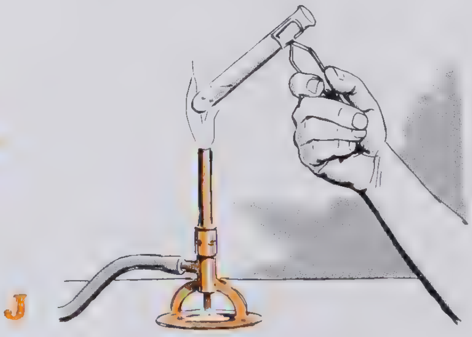
Egg white is almost pure protein. Add 10 drops of **biuret** solution to mashed egg white. Record result.



Hold paper up to light. Record result.

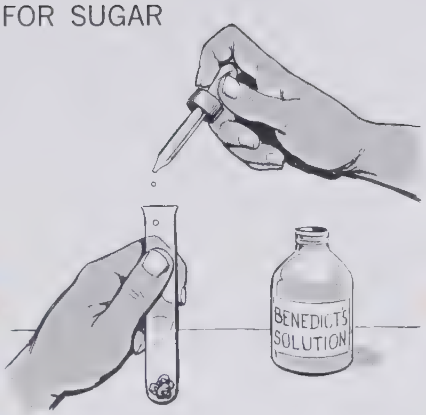
5. Does a plain water spot look like this?

TEST FOR WATER



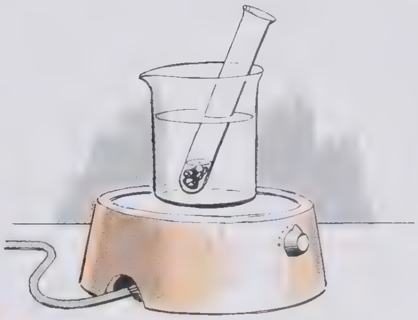
Heat a small piece of food in the test tube.

TEST FOR SUGAR



C

Simple sugar is another carbohydrate. Raisins contain simple sugar. Mix 10 drops of **Benedict's** solution with the raisins.



D

Heat the mixture for 3 minutes.

TEST FOR SALT

G

Salt is a mineral nutrient. Add one drop of silver **nitrate** solution to salt water. Record result.

TEST FOR FAT

H

Oil and margarine are fats. Spread some on brown paper.

K

Look for result in the upper part of the test tube. Record result.

L

Pick a food. Decide what nutrients may be in it. Do tests to see if you are right. Record results in last column on NUTRIENT WORKSHEET.

M

Now fill in the rest of the WORKSHEET.

6. You haven't learned any tests for one group of nutrients. Which group is this?

NUTRIENT WORKSHEET

Nutrient	Job in the Body	Test: What Did You Do?	Test: What Did You See?	Foods That Contain the Nutrient
Starch (a carbohydrate)				
Sugar (a carbohydrate)				
Protein				
Salt (a mineral)				
Fat				
Water				

D. THE NUTRIENT BUSINESS

What store in your neighborhood carries over 8,000 different items?

Right, it's the supermarket.

Supermarkets sell most of the food purchased in the United States. They employ about 2 million people. There may be a job—and a career—for you in a supermarket.

A supermarket is run by the store manager. There are several departments: meat; produce, or fresh fruits and vegetables; dairy products; frozen foods; baked goods; groceries; and general merchandise.

DEWYS, INC.

Supermarket manager

Each department has its own manager. There may be an assistant manager. There are also checkers, baggers, wrappers, butchers, stock clerks.

Many employees work part time, often after school. Full-time employees often start as part-timers and work up to better jobs.

You need no special training to start work in a supermarket. But many workers graduate from high school. Some go on to college.

Hourly pay runs from $2.30 to around $7.00 for adults. Managers can earn as much as $30,000 a year.

7. Suppose a stock clerk earns $3.50 an hour. What is the gross pay for a 40-hour week?
8. A store manager earns $30,000 a year. What is the monthly salary?
9. Examine your local supermarket. What departments does it have?

2 VITAMINS

You can buy vitamin pills in any drugstore.

I can't believe I ate the whole thing!
VITAMIN

Don't buy them unless the doctor tells you to take the pills as medicine.

Ads claim that vitamins fight against infection, help your skin and eyes, and help keep you from getting **anemia.** They also tell you that vitamins prevent diseases such as **scurvy** and **rickets.**

All this is true. Then why not buy the pills?

A. THE CURE ISLAND

In the days of Christopher Columbus, sailors on long voyages often got scurvy. They developed sore gums, loose teeth, and nosebleeds. They became weak and anemic. The disease sometimes killed them.

On one trip, some of Columbus's sailors were dying of scurvy. He left them on an island in the West Indies, and sailed away.

Stopping at the island on his way home, Columbus found that the sailors were having a ball. Eating fresh fruit had cured them. The island is still called **Curacao** from the Portuguese word for "cure."

word guide

anemia	*uh-NEE-mee-uh*
citrus	*SIT-ruhs*
Curacao	*kyoor-uh-SOH*
indophenol	*in-doh-FEE-nohl*
rickets	*RIK-its*
scurvy	*SKUHR-vee*

B. THE LIMEY EXPERIMENT

Dr. James Lind showed how the fresh fruit worked. Around 1800 he fed orange, lemon, and lime juice to British sailors. They didn't get scurvy. Only the men who refused the juice became ill.

The British navy began giving lime juice to all its sailors. British seamen are still called "limeys."

Oranges, lemons, and grapefruit are **citrus** fruits. They contain very small amounts of a nutrient that prevents scurvy. This nutrient was named vitamin C.

PARKE, DAVIS AND COMPANY

Dr. Lind treating British sailors

By experiments like Dr. Lind's, other vitamins were discovered in foods. Some were given chemical names, and others were named by letters.

The various vitamins help regulate the body. Each vitamin prevents a particular disease.

C. GETTING VITAMINS THE EASY WAY

The vitamin table shows some of the many foods that contain vitamins. It is easy to get all the vitamins you need. Eat a large variety of foods. Drink some citrus or tomato juice every day.

Each food contains a very, very tiny amount of vitamins. However, you need only small amounts to stay healthy.

There is no need to pop vitamin pills. In fact too many vitamins can do harm. Only if you are really low in vitamins will the doctor prescribe pills.

1. How does vitamin C help you?
2. Which vitamins help your teeth? Your eyes? Your skin?

VITAMIN TABLE

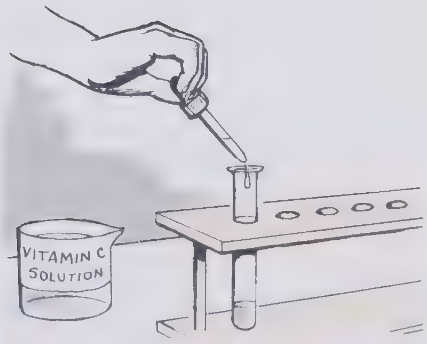
Vitamin	How It Helps the Body	Foods That Contain It
A	Prevents night blindness Helps the skin Helps prevent infection	Eggs, milk, cheese, Liver, Green & yellow vegetables
B complex (group of several vitamins found together)	Helps growth Helps digestion Helps keep skin and nervous system healthy Helps prevent anemia	Eggs, milk, meat, Fruit, vegetables, Whole wheat bread or cereal
C	Keeps blood vessels healthy Prevents scurvy	Oranges, lemons, Leafy vegetables, Tomatoes
D	Keeps bones and teeth healthy Prevents rickets	Fortified milk, Made in skin by sunlight
K	Helps blood to clot	Leafy vegetables, Made in body by bacteria

The VITAMIN ACTIVITY shows how you can measure small amounts of one vitamin.

VITAMIN ACTIVITY

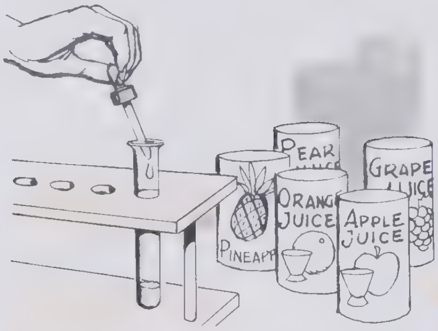
A

Indophenol is a blue chemical that is made colorless by vitamin C. The richer a food is in vitamin C, the easier it bleaches the indophenol.



B

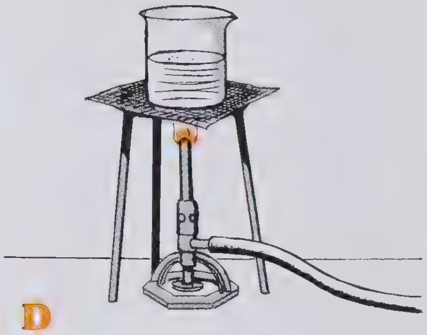
Pour 2 cm (one inch) of indophenol into the test tube. Add vitamin C test solution drop by drop. Shake test tube after each drop. Record number of drops it takes to make color disappear.



C

Use fresh indophenol. Test fruit juices for vitamin C. Record number of drops of each juice needed to bleach the color.

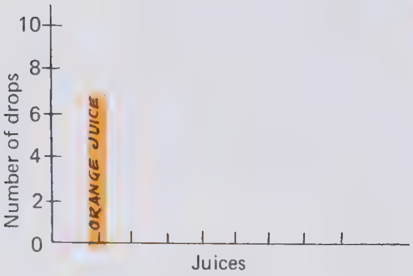
3. Which juice is richest in vitamin C?
4. Which is poorest?



D

Heat one of the juices. Record how many drops it now takes.

5. How does heating effect vitamin C?



E

Make a graph of your results. Section D will help you.

D. BAR GRAPHS

A graph shows numbers in picture form. The graph that you make in step E of the Vitamin Activity is called a bar graph. Each bar represents a number. The orange juice example represents 7 drops.

6. What information is given along the bottom of the graph?

7. What does the scale on the side tell you?

Now, in the graph that you make in your notes, carefully draw bars representing the other juices that you used.

3 WHAT'S SO GREAT ABOUT MILK?

"Drink your milk. It's good for you."

Have you ever heard this? Millions of mothers say it every day to millions of kids.

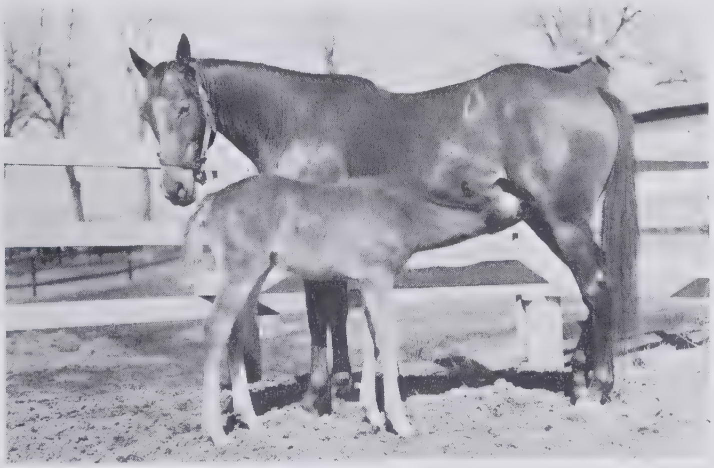
So what's so great about milk?

word guide

allergic	*uh-LUHR-jik*
albumin	*al-BYOO-muhn*
curdle	*KUHR-duhl*
fortified	*FAWR-tuh-fyd*
kwashiorkor	*kwosh-ee-AWR-kawr*
weaned	*WEEND*
whey	*HWAY*
yogurt	*YOH-ghurt*

A. EVERYBODY'S FIRST MEAL

All mammal mothers nurse their new babies. They give the baby milk as its first and only food. So milk must be nutritious.



SPERRY NEW HOLLAND

For most children, milk is an almost perfect food. Water, protein, fat, sugar, minerals, and vitamins are found in milk. However, a few important nutrients are lacking in cow's milk. Therefore, cow's milk is **fortified** by adding these missing nutrients.

1. Look at the printing on a milk carton. What nutrients have been added to fortify the milk?

B. YOU STILL DIG IT

A baby is **weaned** by gradually feeding it other foods in addition to milk. However, people continue to drink milk throughout life. The table tells how much is recommended.

MILK RECOMMENDATIONS
FOR DIFFERENT PEOPLE

Types of People	Amount Recommended
Teen-agers	4 glasses daily
Men and women over 18	2 glasses daily
Pregnant women	4 glasses daily

Milk has such a rich supply of nutrients that other dairy foods can be made from it.

The MILK ACTIVITY will show you how to find the various nutrients.

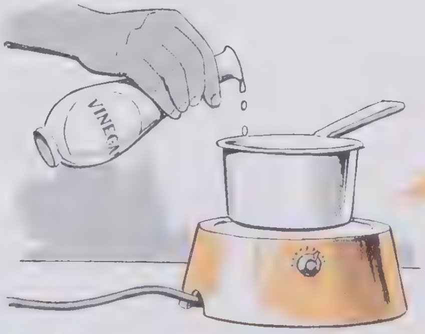
MILK ACTIVITY

A

Butter is made from the cream or fatty part of milk. Pour out some cream. Add a few drops of lactic acid.

B

Shake the cream in a test tube until the butter floats on top. Pour into a dish and skim off the butter. Squeeze the butter into a pat.



C

Buttermilk is left. Warm it. While stirring, slowly add a little vinegar. The buttermilk will **curdle.**

D

Pour the curdled milk through a filter. The **whey** goes through. The curd stays on the filter; it is used to make cheese.

E

Boil the whey. Then filter out the **albumin** that appears. This is good protein.

F

Over a steam bath, boil away the remaining liquid. Milk sugar will be left. Can you find it?

G

Heat some whole milk. It will start to burn. Keep heating it. The ash that is left contains the minerals of the milk.

H

Show everything that you have gotten from the milk. Can you prove by doing tests that milk contains protein, fat, and carbohydrate?

You can get part of your daily milk requirement by eating ice cream, cheese, **yogurt,** or buttermilk. The last two are soured acid products made from milk.

These dairy foods supply only part of the requirement. Most people still need some milk each day.

C. THE HIDDEN HUNGER

Suppose you don't get the good nutrients that milk provides?

This is a very real problem in poor, crowded countries of the world. It is a problem among poor families in this country.

Milk is expensive. Starchy foods are much cheaper. When a baby is weaned, it is easy to give it a lot of starches and not enough proteins.

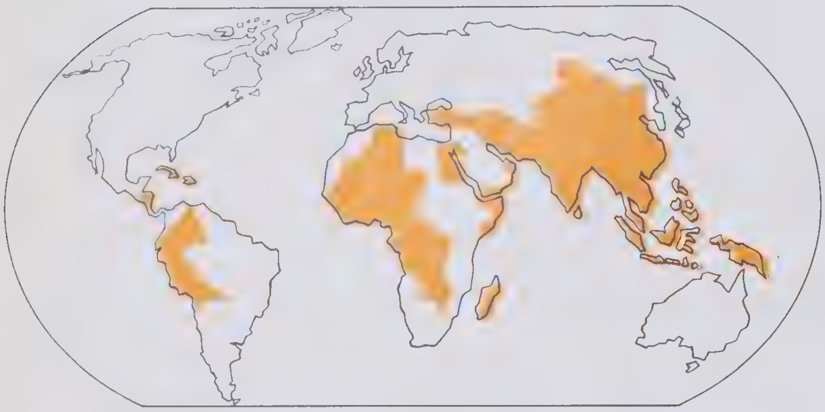
The baby then especially misses the protein found in milk. It is likely to develop a disease—a hidden hunger—called **kwashiorkor.** The name is African, but the disease is worldwide.

The child's belly swells, its hair turns red, and a skin rash develops. It becomes weak, stops growing, and easily falls victim to other diseases.

What is the treatment for kwashiorkor? You know the answer. Give the child a diet that has enough good protein. Make sure that the child gets some milk.

If fresh milk is too expensive, powdered milk is just as good. For people **allergic** to cow's milk, substitute milk made mostly from soybeans has proven almost as good as the real thing.

Being allergic means that you are sensitive to foods or other things. The other substances may be pollen, dust, or animal hair. The allergy shows for example as a skin rash, diarrhea, asthma, or running eyes or nose.



Areas of the world where protein is short

UNITED NATIONS PHOTO

Asian children drinking a milk substitute

2. List all the nutrients that you found in milk.
3. What different dairy foods made from milk have you eaten?
4. What would you do about kwashiorkor in poor countries?
5. What would you do about kwashiorkor in this country?

4 THE COW IN THE KITCHEN

word guide

dextrin
DEK-strin
digest
dy-JEST

You have never seen a cow in the kitchen. You never will. Animals don't cook their food.

People do cook their food. Cooking is one of the earliest human inventions, and one of the most important.

A. RAW POTATOES, ANYONE?

You like some foods raw—apples, grapes, tomatoes, nuts, maybe carrots. But most of your food is cooked. Let's see what cooking does to food.

Did you ever eat a raw potato? It was probably hard to get down. Cooking softens potatoes and other foods. Then we can chew and swallow them easily.

A baked potato is easy to **digest.** Digesting means making food usable in the body. Cooking makes it easier for you to digest food. A baked potato tastes good, too. Cooking brings out the flavor in foods.

Maybe you like raw eggs. Most people don't, because of the way they feel in their mouth. Cooking improves the way eggs and various other foods feel in your mouth.

B. COMPETING WITH GERMS

Finally, cooking kills harmful germs in food. Cooked food is healthful for you.

Cooked food is also attractive to new germs. So cooked food that isn't used immediately should go into the refrigerator. The germs that cause food poisoning can grow quickly in foods that are left out.

1. Can you list 5 reasons for cooking food?

What are you doing?
Making my own glue!
ENRICHED BREAD

C. TOAST AND POSTAGE STAMPS

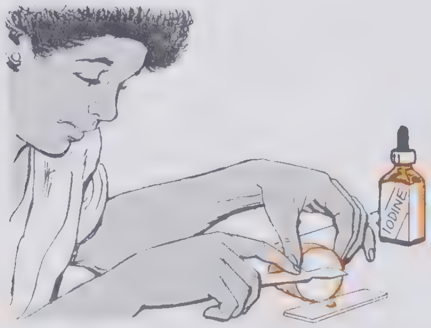
The glue on the back of postage stamps is called **dextrin.** It is a form of starch. The STARCH ACTIVITY shows how you can make dextrin, and use it.

Cooking breaks up the starch grains in raw food. When the starch is released from its grains, it becomes more digestible.

If you continue to heat the starch, it turns into dextrin. This happens in toast and in the crust of bread.

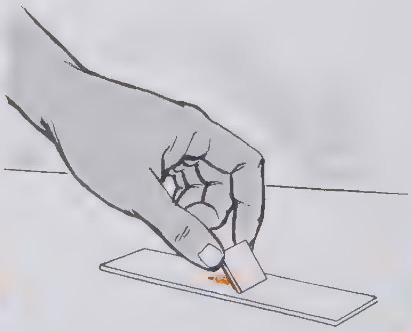
Dextrin is even easier to digest than dissolved starch. That is why toast is given to sick people instead of plain bread.

STARCH ACTIVITY



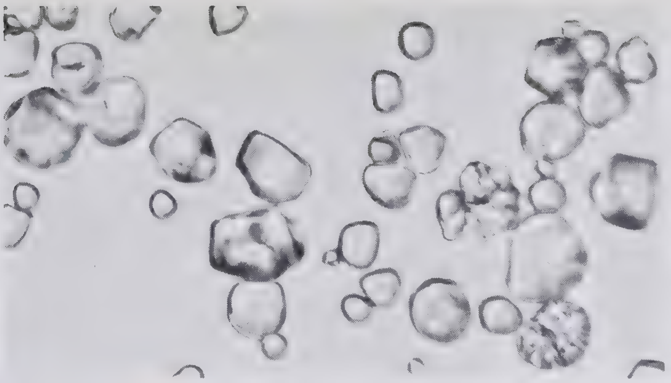
A

On a slide, scrape some raw potato into a drop of weak iodine. Mix well.



B

Add a cover slip. Examine with a microscope.

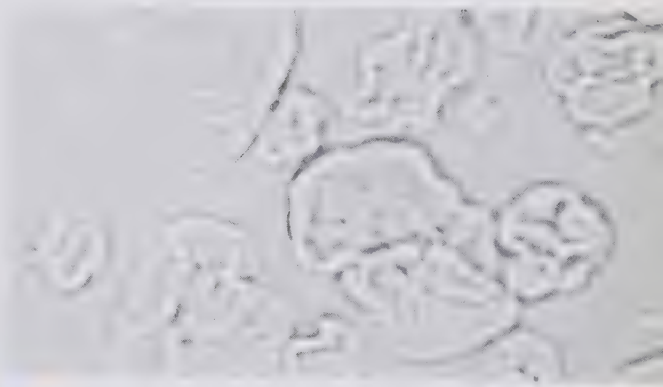


CORN PRODUCTS

C

Find the starch grains.

2. How can you recognize them?
3. What did the iodine do to them?
4. Why?

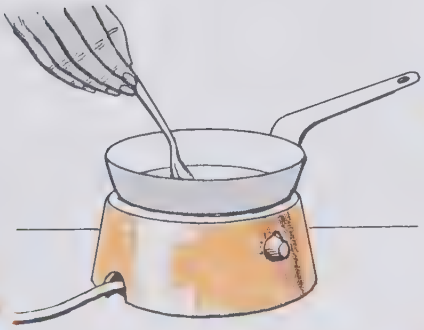


CORN PRODUCTS

D

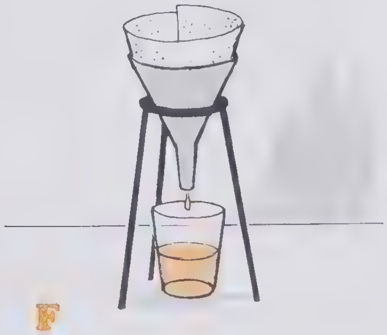
Do the same with a little boiled potato.

5. What do you notice about the starch?



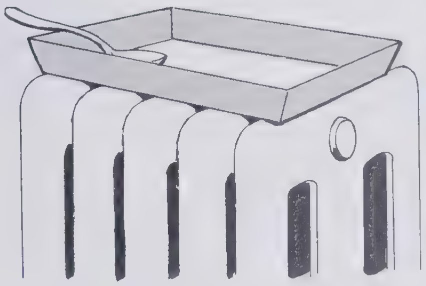
E

Place 2 spoonfuls of starch in a pan. Heat gently while stirring, until the starch turns brown. Don't let it burn. Or instead, you can scrape off and collect the brown portion of a slice of toast.



F

Stir the brown starch in a cup of water. Filter the mixture through paper towelling.



G

Then dry it.

H

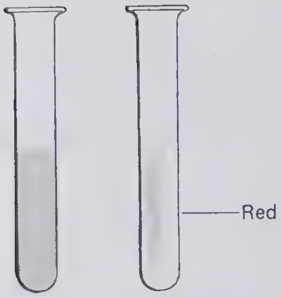
The brown, dried material is dextrin. Feel it between damp fingers.

6. What does it feel like? Try gluing some paper with the dextrin.

I

Taste the dextrin.

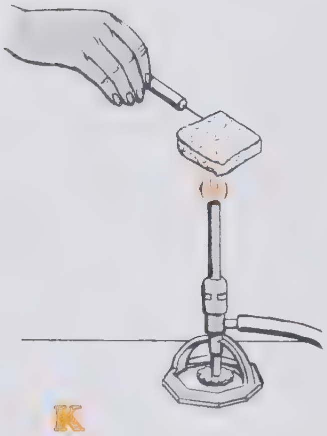
7. How does it taste? Do you like the taste?



J

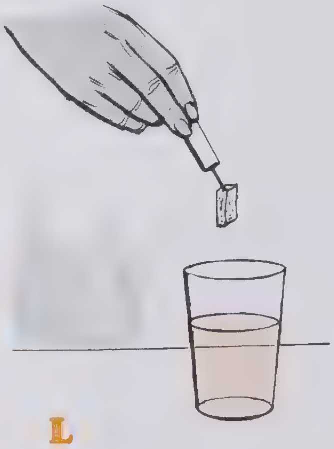
Take 2 tubes of weak iodine solution. Add starch to one tube and dextrin to the other. Stir.

8. What is the test for dextrin?



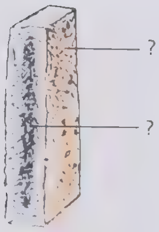
K

Toast a piece of white bread.



L

Cut it in strips. Dip one strip in a glass of weak iodine.



M

9. Where do you find the dextrin?
10. The starch?

11. Why is starch used to thicken puddings? (See if you can find any actual starch in some puddings.)
12. Why is dextrin used on postage stamps?

5 SCIENCE IN THE KITCHEN

Probably your parents aren't really scientists. But when they cook, they do many things that a laboratory scientist does.

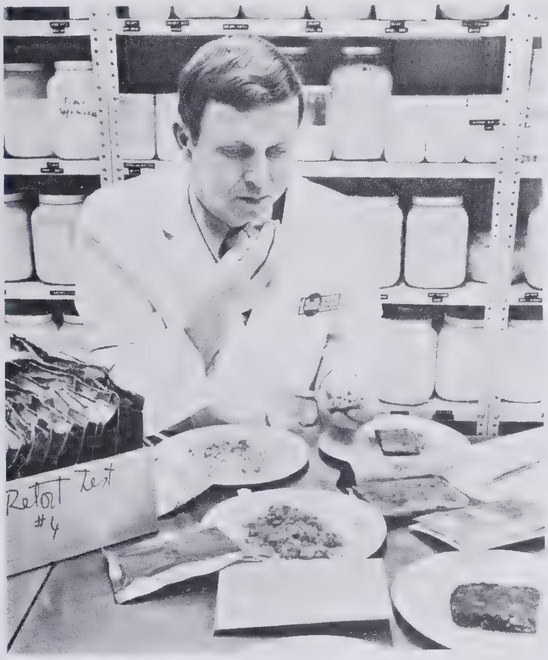
They heat things. They use weighed and measured amounts. They make solutions and mix chemicals. They store materials in the refrigerator to protect them from germs.

All this makes sense. The same scientific laws that work in the lab also apply in the kitchen. So every cook has to use some science.

In fact there are highly trained scientists who specialize in foods. Food technologists work in food industries. Dietitians work mainly in hospitals. Let's try some food science.

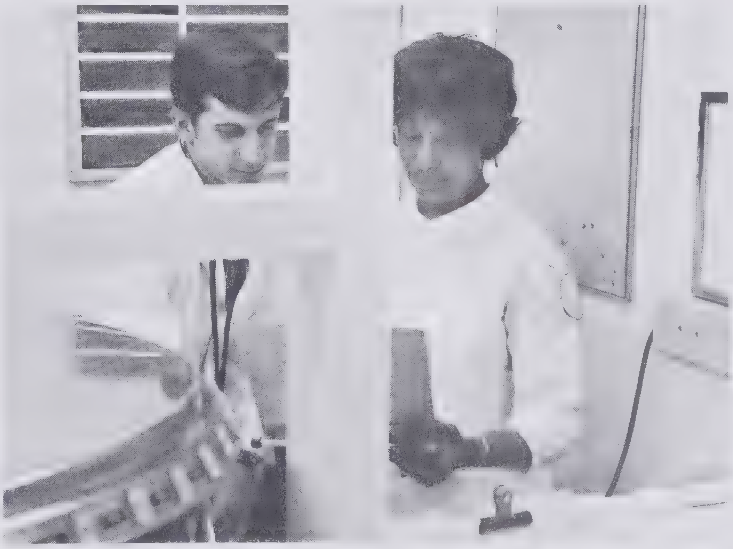
word guide

acid	*AS-id*
membrane	*MEM-brayn*



SWIFT AND COMPANY

A food technologist at work



COURTESY OF THE AMERICAN DIETETIC ASSOCIATION

A doctor and a dietitian planning a patient's diet

A. CELLS IN THE KITCHEN

All the foods we eat, except for salt and water, come from plant or animal tissues. These tissues are made of cells, like the pulp cells of an orange.

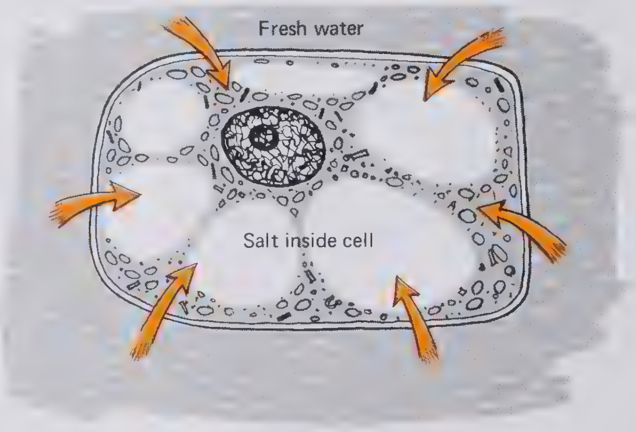
Every cell has a thin **membrane** around it. The membrane keeps the juice inside the cell. The juice gives the food flavor. It contains many nutrients. It makes the cells plump. Vegetables are crisp and tasty when their cells are plump.

Usually we want the juices to stay inside the cells, and inside the food. That is why we start cooking meat on a high flame. The proteins in the outer cells of the meat turn hard, like a hard-boiled egg.

The flame is then turned down. The inside of the meat cooks more slowly and retains its juices.

B. PULLING POWER

Sugar and salt can pull liquid into a cell, right through the membrane. By soaking vegetables in fresh water, we keep them crisp. The salt already inside the cells draws in some water, and the cells stay plump and crisp.

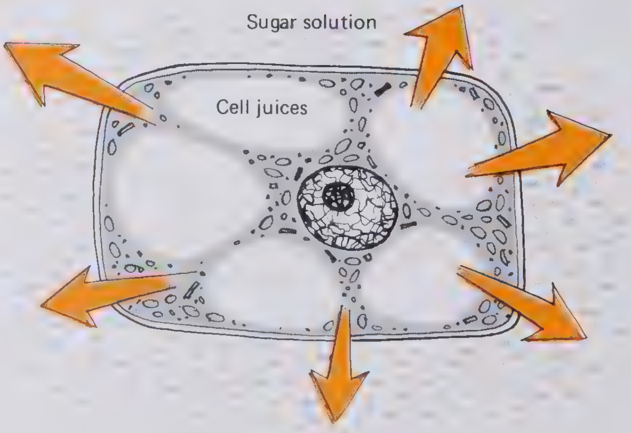


Sugar and salt can also pull liquid out of a cell. Sometimes we use them to draw out the cell juice, with its flavors.

This is why adding sugar to a slice of fresh fruit makes it seem juicier. The juice is drawn out of the cells. Also, adding salt to stew draws out the meat flavor.

1. Why do vegetables wilt in salt water?
2. Why does a storekeeper sprinkle vegetables with fresh water?

C. CABBAGE CHEMISTRY



There are other remarkable things about the juices in cells. Some of them are mild **acids.** They taste sour.

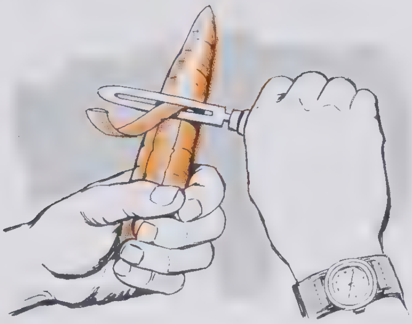
Others are chemically opposite. They are called bases. They have a slightly soapy taste.

Some plant juices contain sensitive dyes. You can use the dye in red cabbage juice to test acids and bases in various foods.

Perhaps you never realized that food has so much science connected with it. We have only scratched the surface of this subject. But the VEGETABLE ACTIVITY will give you a chance to try some experiments with cell juices.

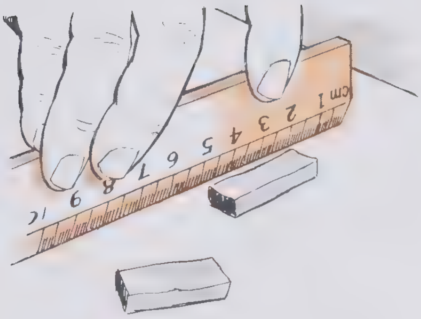
VEGETABLE ACTIVITY

SALT WATER AND FRESH WATER



A

Make several thin carrot strips.



B

Slice a beet. Cut out 2 equal blocks. Measure and record lengths.

C

Put one beet block and several carrot strips in jar of fresh water. Do the same in a jar of very salty water.

D

Examine the vegetables every 5 minutes.

EFFECTS OF SOAKING VEGETABLES IN FRESH WATER AND IN SALT WATER

	Appearance after soaking in		Length after soaking in	
	Fresh water	Salt water	Fresh water	Salt water
Beet				
Carrot				

E

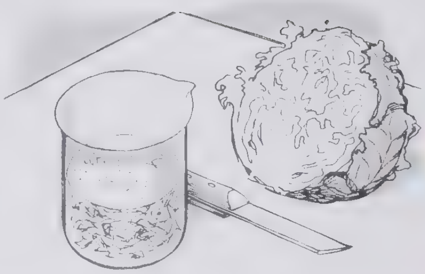
Measure final length of beet blocks. Record all final results in a table such as this.

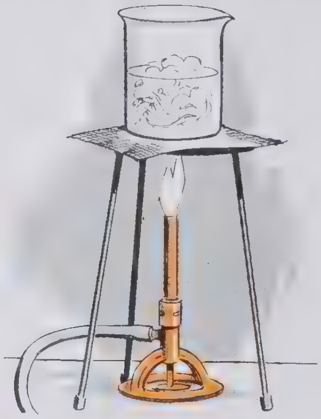
3. How did salt affect the beet blocks?
4. How did it affect the carrot strips?

TESTING FOR ACID AND BASE

F

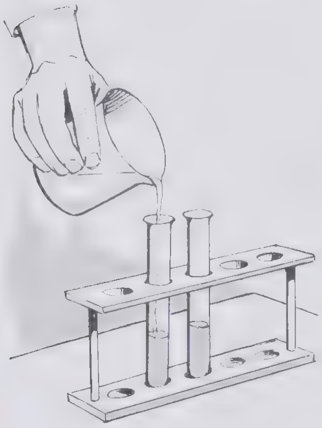
Meanwhile, place some chopped up red cabbage in a beaker of cold water.





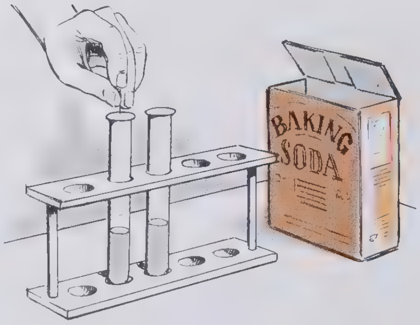
G

In another beaker, boil some of the cabbage. Boiling destroys the cells. Explain difference from the first cabbage.



H

Deep purple cabbage water is ready to use for tests. Put 5 cm (2 inches) in each of 2 test tubes.



I

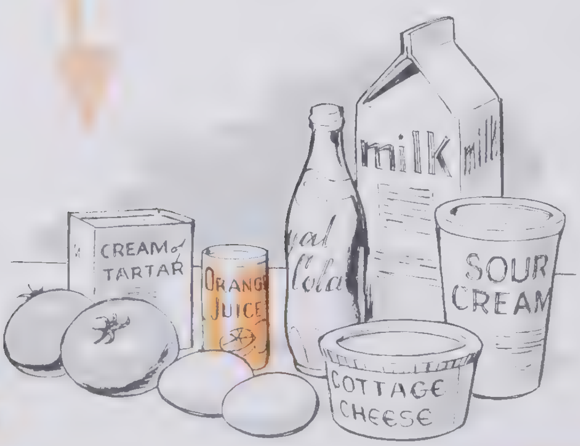
Baking soda is a base. Add a pinch to one tube of red cabbage juice.

5. What color change is test for a base?

J

Vinegar is an acid. Add a few drops to second tube of red cabbage juice.

6. What color change is test for an acid?



K

Use red cabbage juice to find out which foods are acid and which are basic.

ACID AND BASIC FOODS

Food	Acid or Base
Baking soda	Base
Vinegar	Acid

L

Copy table. List and record results of your tests.

6 COUNTING CALORIES

People on diets talk a lot about **Calories.**

Do you think your little sister should have all those calories?
Lets go get some calories.
I'd rather have a pizza!

People can count Calories, or talk about them, without being exactly sure just what they are.

word guide

Calorie	*KAL-uh-ree*
calorimeter	*kal-uh-RIM-uh-tuhr*
Celsius	*SEL-see-uhs*
metric	*MET-rik*
milliliter	*MIL-uh-lee-tuhr*

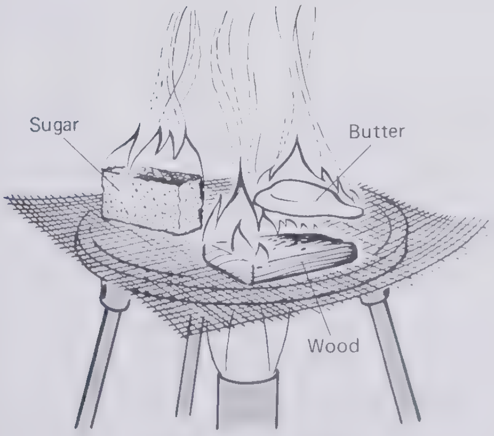
A. WHAT'S A CALORIE?

It isn't hard to explain. A Calorie is a unit used for measuring, like a liter, a meter, or a gram.

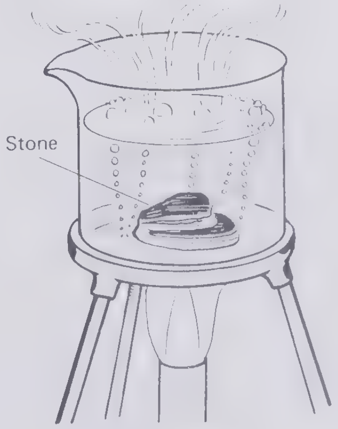
It doesn't measure length or weight. It measures heat energy. Anything that will burn releases heat energy. Therefore, anything that burns contains Calories.

Wood, paper, and gasoline all contain Calories. They all burn. All nutrients, except minerals and water, contain Calories.

1. Why don't minerals and water contain Calories?



CONTAIN CALORIES



NO CALORIES

Your body contains Calories. When you burn foods in your cells, you release Calories of heat energy. They keep you warm. They give you the energy to live.

B. HOW CALORIES ARE MEASURED

The only way to find out the number of Calories in a food or fuel is to burn it. Then measure how much heat it produces.

A commercial calorimeter

CALORIE TABLE

	100 Calorie Portions
MEAT GROUP	1 small hamburger ⅔ of a frankfurter 2 strips of bacon 1 small slice of roast beef
MILK GROUP	½ cup of milk ½ scoop of ice cream
FRUITS AND VEGETABLES	1 apple 2-3 medium peaches 1 medium potato ⅓ cup of baked beans 4 tomatoes 2 heads of lettuce
BREAD GROUP	1½ slices of bread ½ sweet roll ⅓ slice of apple pie

It won't do just to measure the temperature of the burning material. For example, a gram of butter and a kilogram of butter burn at the same temperature.

In the kilogram there is, of course, more butter. So when the kilogram of butter burns, it releases more Calories of heat energy than the gram of butter releases.

Calories in food are measured in a **calorimeter** or "Calorie measurer." You can make and use a "tin-can calorimeter."

The food burns in the calorimeter. It heats a measured amount of water. The water takes up the heat released by the burning food.

If you multiply the amount of water by its rise in temperature, you can figure the Calories in the food. The CALORIES WORKSHEET shows you how to do this.

The calorimeter is planned for use with **metric** measurements. Therefore temperature must be measured in degrees Celsius, water in **milliliters** (ml), and weight in grams.

C. HOW MANY CALORIES IN A DOUBLE DIP?

Tables like this give the number of Calories in various foods. The table was made by burning the foods, one at a time, in a calorimeter.

CALORIES WORKSHEET

This example will help you to figure the Calories in food that you burn in your calorimeter. Copy and use this form.

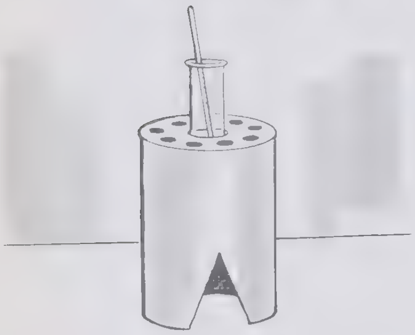
	EXAMPLE	YOUR EXPERIMENT
Amount of water used in milliliters (ml)	15 ml	______ ml
Temperature of water in degrees Celsius (°C) before food was burned	18°C	______ °C
Water temperature after food was burned	98°C	______ °C
Subtract first temperature from second to get rise in temperature (EXAMPLE: 98° − 18° = 80°)	80°C	______ °C
Multiply rise in temperature by amount of water. (EXAMPLE: 80° × 15 ml = 1200 c) Answer is in small calories	1200 calories	______ calories
To change to large Calories, divide by 1000. (EXAMPLE: 1200/1000 = 1.2 C)	1.2 Calories	______ Calories

D. GOING CELSIUS

The following exercises will help you to become familiar with the Celsius temperature scale. Copy the table in your notes. Predict what you think each temperature will be. Then measure the temperature. How close did you come?

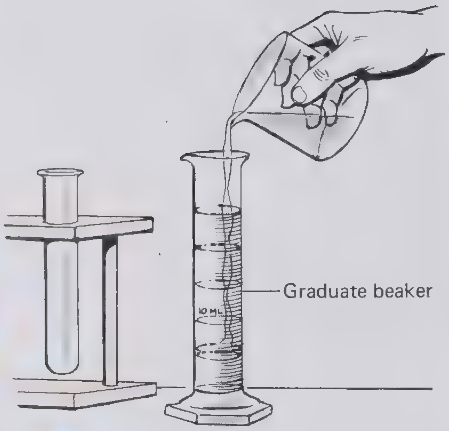
Temperature Measured	Prediction	Measurement
Boiling water	______	______
Ice water	______	______
Air in the room	______	______
Outside air	______	______
Your mouth temperature	______	______

CALORIMETER ACTIVITY



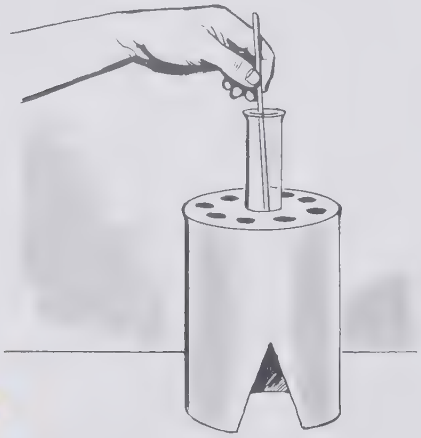
A

Cut out tin can calorimeter. A test tube should just fit in the center hole. The other holes are for air.



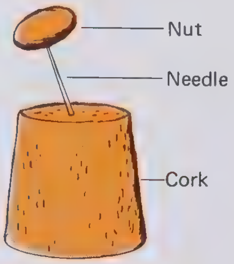
B

Measure 10 ml of water into a test tube.



C

Put test tube in calorimeter. Measure and record beginning temperature of water. Remove thermometer.

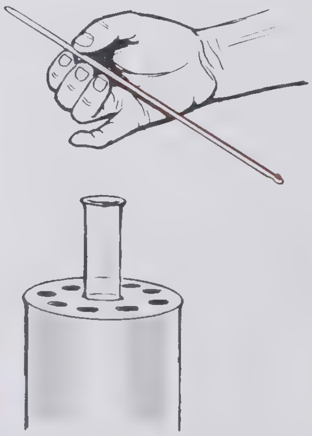


D

Dip a nut in ashes so it will catch fire easily. Then fasten it to the cork. Set fire to the nut.

E

Put nut in calorimeter. Let it burn out.



F

Measure and record final temperature of water.

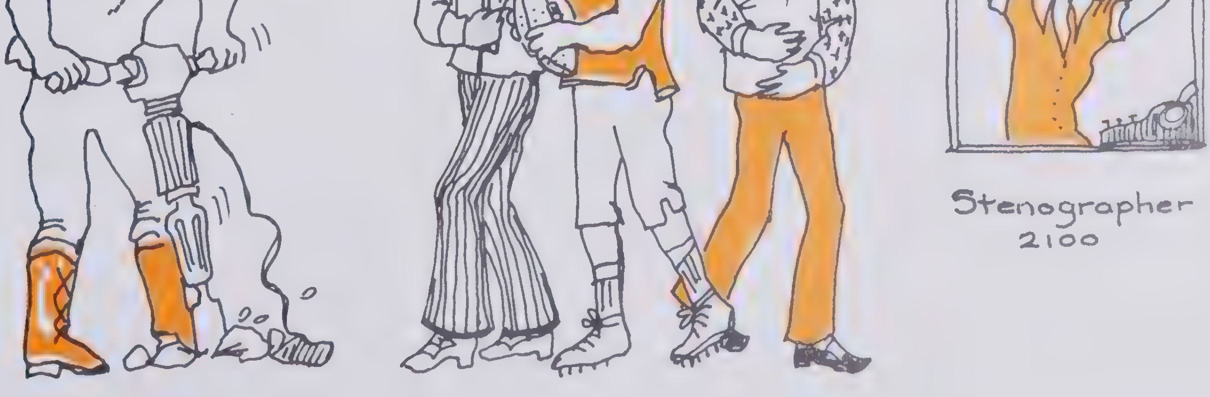
G

Use CALORIES WORKSHEET to figure the Calories of heat released by the burning nut.

7 YOUR RIGHT WEIGHT

Poor eating habits are a bad scene, even though they won't change your appearance as much as this fun house mirror will.

How many Calories a day do you need? That depends on how big and how active you are. A big, active man uses a lot of energy, and needs a lot of food. A less active person needs fewer Calories.



A. WHAT'S YOUR RIGHT WEIGHT?

If you look healthy and feel healthy, you are probably the right weight for your build. To keep your weight right, eat 3 good meals a day without stuffing. Cut down on snacks. Snacks throw your weight control way out of balance.

"Chow hounds" eat more Calories than they can burn up. They need some extra Calories for growth. The rest go to fat.

People who eat less than they need are likely to be low in energy, and underweight. To get energy, they can actually be burning their own tissues.

B. CHECKING YOUR WEIGHT

The table gives average weights for boys and girls of different heights.

TABLE OF AVERAGE WEIGHTS (kg)

Height (cm)	12 years		13 years		14 years		15 years		16 years		17 years	
	B	G	B	G	B	G	B	G	B	G	B	G
130	28	29										
134	30	31	30	32								
138	32	33	33	34	33	35						
142	34	35	35	36	35	37	36					
146	37	38	38	38	38	40	38	42		44		
150	40	41	40	41	41	43	41	45	41	46		47
154	43	44	43	45	44	47	45	48	46	50	47	50
158	46	47	46	48	47	49	47	51	49	52	50	53
162	48	50	50	51	50	52	51	53	52	54	54	55
166	52	53	53	54	53	55	55	55	56	56	58	57
170			55	57	57	58	58	59	60	59	61	59
174				60	61	60	61	61	63	62	64	63
178					65	61	65	62	66	63	67	64
182							68		69		70	
186							71		72		73	

TABLE OF AVERAGE WEIGHTS (lbs)

Height (Inches)	12 years		13 years		14 years		15 years		16 years		17 years	
	B	G	B	G	B	G	B	G	B	G	B	G
50	58	62										
51	61	65										
52	64	67	64									
53	68	69	68	71								
54	71	71	71	73	72							
55	74	75	74	77	74	78						
56	77	79	78	81	78	83	80					
57	81	82	82	84	83	88	83	92				
58	85	86	85	88	86	93	87	96		101		
59	89	90	89	92	90	96	90	100	90	103		104
60	92	95	93	97	94	101	95	105	96	108		109
61	96	100	97	101	99	105	100	108	103	112	106	113
62	101	105	102	106	103	109	104	113	107	115	111	117
63	106	110	107	[illegible]	108	112	110	116	113	117	118	119
64	109	114	111	115	113	117	115	119	117	120	121	122
65	114	118	117	120	118	121	120	122	122	123	127	125
66			119	124	122	124	125	125	128	128	132	129
67			124	128	128	130	130	131	134	133	136	133
68				131	134	133	134	135	137	136	141	138
69					137	135	139	137	143	138	146	140
70					143	136	144	138	145	140	148	142
71					148	138	150	140	151	142	152	144
72							153		155		156	
73							157		160		162	
74							160		164		168	

Remember these are average weights. Depending on your build, you may differ a good deal from the weight shown on the table for your height.

The "pinch test" is a useful check. A pinch more than 2 cm (one inch) thick means that you are very likely overweight. A 5 millimeter ($\frac{1}{4}$ inch) pinch probably means that your body doesn't have enough fat on it.

CHECK YOURSELF ACTIVITY

A

Remove your shoes and any outer clothing. Weigh yourself.

B

Have partner measure your height.

C

Check your measurements on the Table of Average Weights.

D

Do the pinch test on yourself. Do you think you are at your best weight?

If you think your weight is wrong and you need to diet, the best deal is to get some help. Ask a doctor, a nurse, or a dietitian. They can tell you how to diet safely.

1. Why does a pro football player generally need more Calories than a bookkeeper?
2. If you eat more Calories than you burn up, does it show in the pinch test?
3. An overweight girl wants to reduce. Why is it a bad idea for her to decide on her own reducing diet?
4. Comment on this quotation: "Exercise helps you keep your right weight. The best exercise is a strong push away from the table."

Just one more bite, dear?
No thank you! I'm trying to keep my figure!

C. GOING METRIC

Most of the world uses the metric system. Soon the United States too will go metric. Scientists have already done so. These exercises will help you become familiar with the metric system.

Guess each of these measurements. Then actually make the measurement. How close were you?

METRIC WORD GUIDE

centi (*SEN-tuh*) = a hundredth
milli (*MIL-uh*) = a thousandth
kilo (*KIL-uh*) = one thousand

5. Place your hands on the desk an estimated one meter apart. Your partner will use a meterstick to check your accuracy.

DIMENSION MEASURED	GUESS	MEASUREMENT
6. How many centimeters high is this book?	_____	_____
7. How many millimeters thick is it?	_____	_____
8. How many grams does it weigh?	_____	_____
9. How many kilograms?	_____	_____

10. Is it better to state the weight of the book in grams or in kilograms?

8 THE BIG FOUR

We call it the Big Four because it can be a big deal for you.

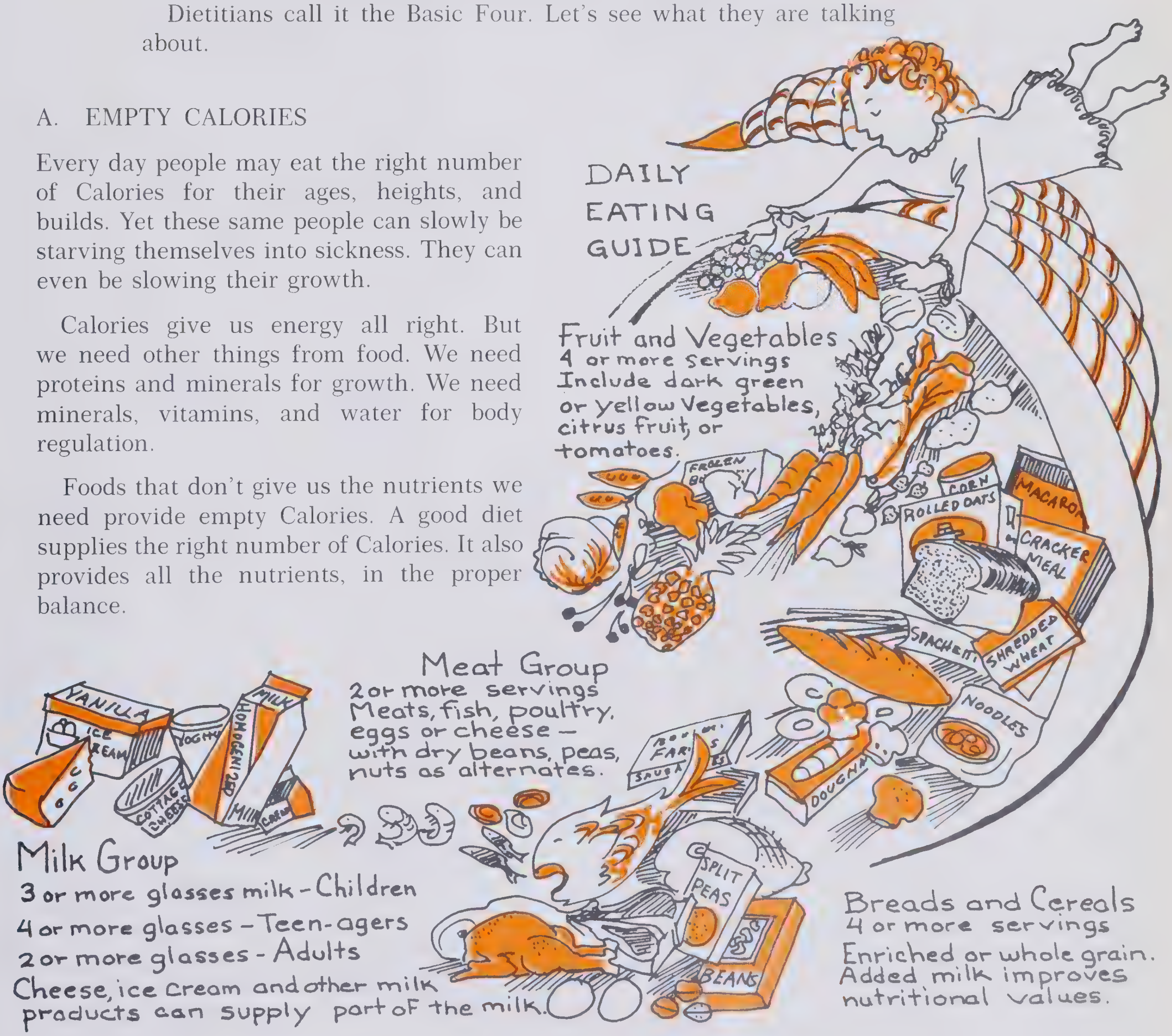
Dietitians call it the Basic Four. Let's see what they are talking about.

A. EMPTY CALORIES

Every day people may eat the right number of Calories for their ages, heights, and builds. Yet these same people can slowly be starving themselves into sickness. They can even be slowing their growth.

Calories give us energy all right. But we need other things from food. We need proteins and minerals for growth. We need minerals, vitamins, and water for body regulation.

Foods that don't give us the nutrients we need provide empty Calories. A good diet supplies the right number of Calories. It also provides all the nutrients, in the proper balance.


DAILY EATING GUIDE
Fruit and Vegetables
4 or more servings
Include dark green or yellow Vegetables, citrus fruit, or tomatoes.
FROZEN
CORN
ROLLED OATS
MACARO
CRACKER MEAL
SPAGHETTI
SHREDDED WHEAT
NOODLES
DOUGHNUTS
Meat Group
2 or more servings
Meats, fish, poultry, eggs or cheese — with dry beans, peas, nuts as alternates.
VANILLA ICE CREAM
YOGHURT
HOMOGENIZED
MILK
COTTAGE CHEESE
SPLIT PEAS
BEANS
Milk Group
3 or more glasses milk - Children
4 or more glasses - Teen-agers
2 or more glasses - Adults
Cheese, ice cream and other milk products can supply part of the milk.
Breads and Cereals
4 or more servings
Enriched or whole grain. Added milk improves nutritional values.

B. THE BASIC FOUR

A dietitian can figure out a custom-made balanced diet that supplies all the nutrients you need. An easier way to figure it out is to use the Basic Four plan.

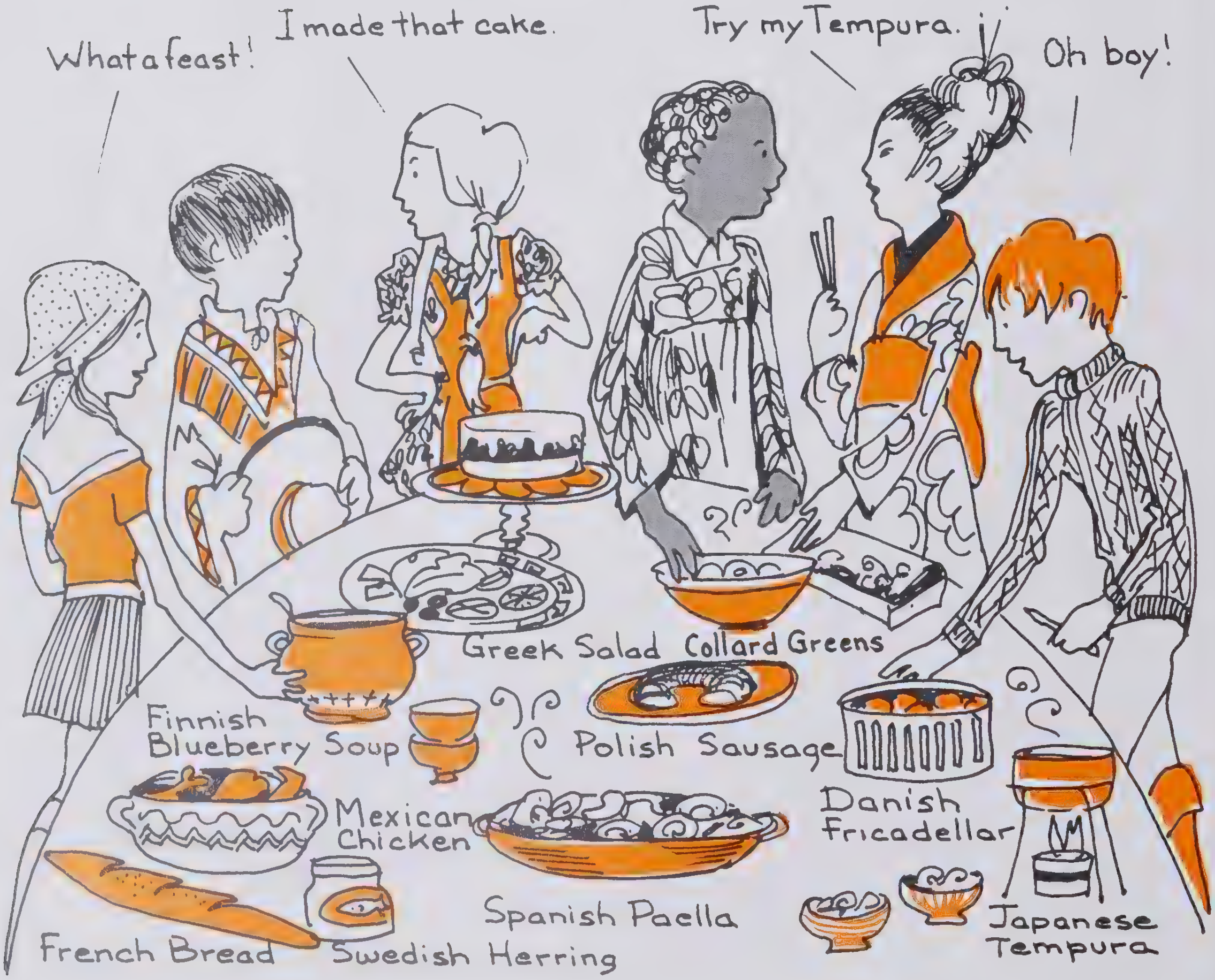
Dietitians have divided foods into 4 groups. They tell us to eat each day the stated number of servings from each group. This is the first step toward a balanced diet.

The second step is to eat a variety of foods. Suppose you like bananas. Four servings of bananas a day won't do for the Vegetables and Fruits group. You also need some green and yellow vegetables, and some citrus and other fruits.

The third step is to eat 3 meals a day. Don't skip breakfast. It is the most important meal. It comes after a long night's fast and before the busiest time of the day.

C. VARIETY COUNTS

The idea is to eat many different foods. Some of the menus shown here may be strange to you. Try some new foods. They will add variety to your diet, and you may find you like them.



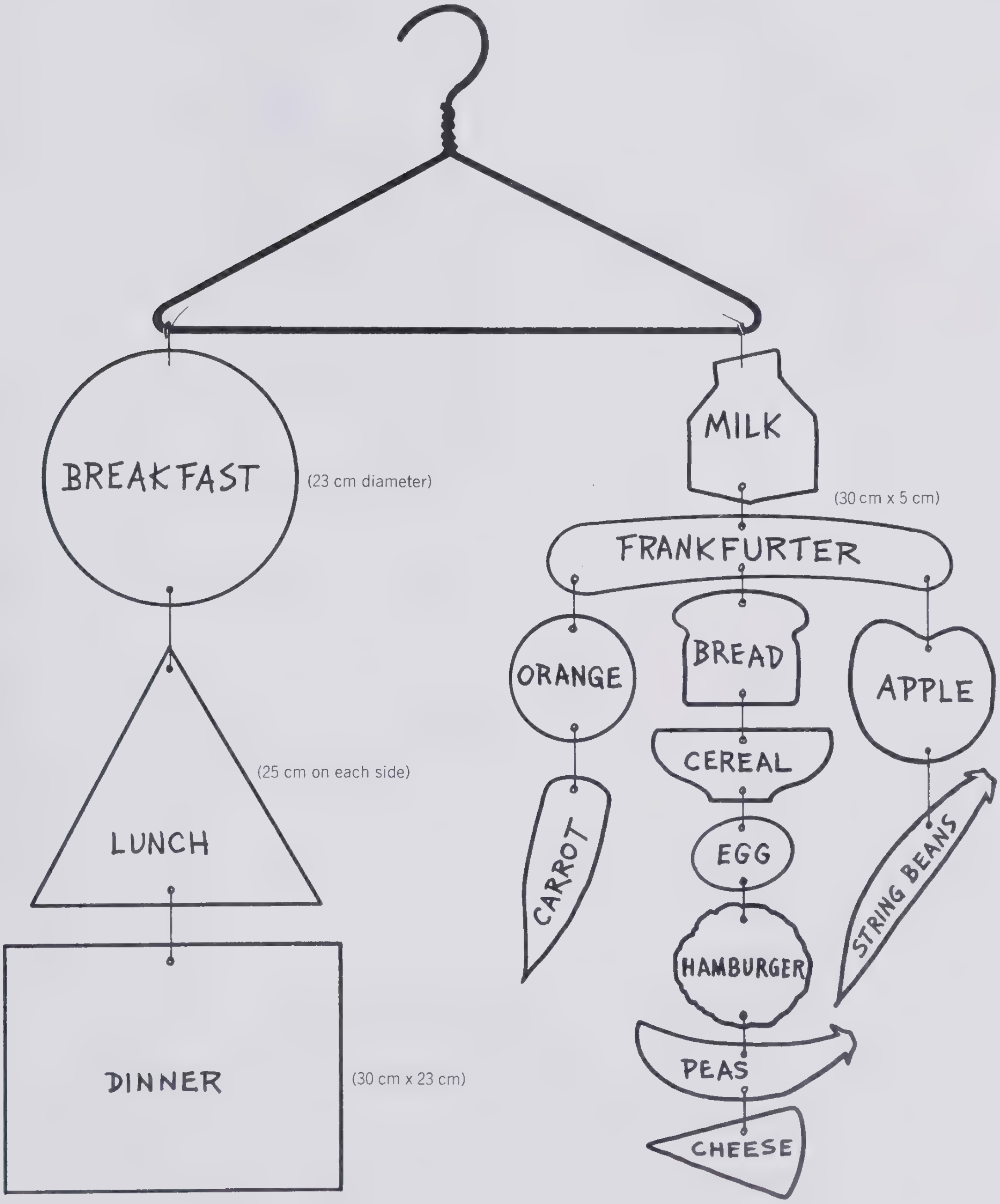
By sticking mainly to hot dogs, or hamburgers, or pizza, you will surely miss out on some of the nutrients. Hot dogs and pizza are fine, but eat them as part of a varied and balanced diet.

The Basic Four plan makes sense. You can play games with it.

D. A FOOD MOBILE

Use a coat hanger to build a food mobile representing a balanced diet.

Cut 3 meal cards out of cardboard. Hang them on the left.



Cut food cards out of cardboard, also. Hang them on the right. You must have at least one food from each of the Basic Four groups for each meal. So you need at least 12 foods. You may have to change the sizes of the cards to get a balance.

When the coat hanger hangs level, your diet is in balance.

E. BASIC FOUR RUMMY

Using index cards, make a deck of 48 cards. Each card bears the name of a food. Print 2 cards for each food.

MILK GROUP—Choose 3 foods:
milk
margarine
American cheese
cottage cheese
ice cream
yogurt

MEAT GROUP—Choose 4 foods:
chicken
meat
pork
eggs
fish
hot dog
dry beans
peas
peanut butter

BREADS AND CEREALS GROUP—Choose 7 foods:
bread
rice
doughnut
corn meal
spaghetti
macaroni
potato
cookies
cake
oatmeal
cereal
crackers

EMPTY CALORIES GROUP—Use all:
Soda pop
Coke
Tea
Coffee
Candy
Sugar

VEGETABLES AND FRUITS GROUP—Choose 4 foods:
tomato
carrots
corn
sweet potato
greens
string beans
orange
banana
watermelon

Here are the rules:

1. Two or 3 may play.
2. Choose for dealer.
3. Deal 8 cards to each player. Turn up one card. Place the rest of the deck face down.
4. Starting at the dealer's left, each player in turn draws a card. He or she may draw the top card from the deck, or the top face-up card. The player discards one card face up.
5. A player may knock when he or she holds cards for 2 different meals. Each meal must have one food from each of the Basic Four food groups. The player lays down the hand.
6. Others check the hand. If the player knocked correctly, he or she gets 2 points. If not, the player loses one point.
7. If the deck is used up and no player has knocked, turn over the face-up pack and continue.
8. The winner is the player with the most points when the game is called.

9 BELIEVE IT OR NOT ABOUT FOOD

People select the food they eat for many reasons. Sometimes they choose what they eat because of their likes and dislikes. Sometimes they select their food on the basis of what they can afford.

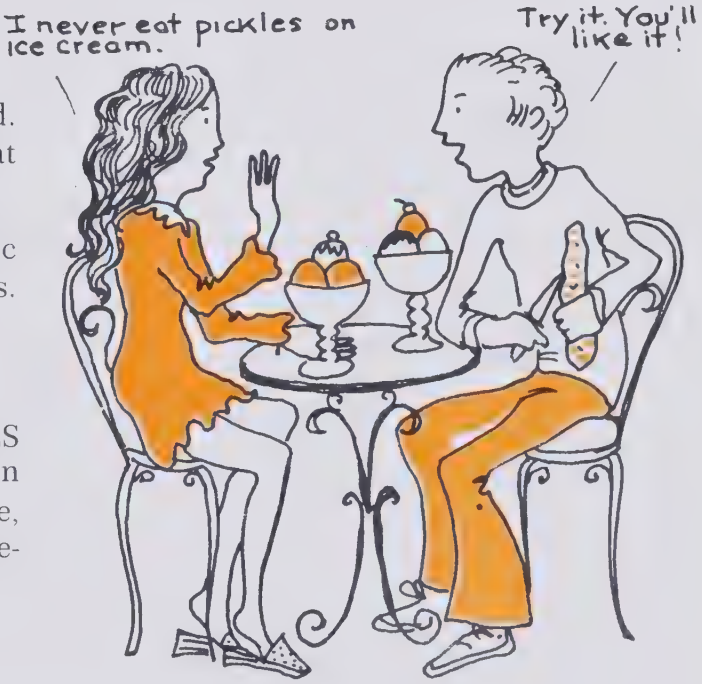
Many times eating habits of their family or social group help people decide what to eat. Often, people eat what they do because of time. When you are in a hurry, don't you tend to "grab a bite?"

A. FOOD FADS AND FANCIES

There is still another basis for selecting food. People often have strong beliefs about what food can do for them.

Some of these beliefs have a scientific basis. Some are fads. Some are superstitions.

The FACTS, FADS, AND FANCIES WORKSHEET lists beliefs about foods. In your notes indicate whether you agree, disagree, or don't know about each statement.


I never eat pickles on ice cream.
Try it. You'll like it!

Facts, Fads, and Fancies Worksheet

1. Pickles and ice cream don't mix.
2. An attractively set table helps digestion.
3. You should take some tomato or citrus juice daily.
4. Oranges and lemons cause "acid stomach."
5. You cannot be healthy on a vegetarian diet.
6. Milk helps build bones and teeth.
7. Some chemicals that manufacturers add to foods can be dangerous.
8. "Natural" or "organic" foods don't contain chemicals.
9. Tomatoes are poisonous.
10. It is dangerous for children to eat paint from the walls.

FACTS, FADS, AND FANCIES WORKSHEET (continued)

11. You should take pills if you have "tired blood."
12. Everybody should take vitamin pills daily.
13. There are "yin" and "yang" foods, or male and female foods.
14. Expensive cuts of meat are more healthful than cheap cuts.
15. Safflower oil is good for reducing.
16. Cheese is hard to digest.
17. Some people are sensitive to particular foods.
18. A pregnant woman needs special foods.
19. Being overweight is a serious health problem in the United States.
20. Most diseases are due to bad diet.
21. Processing removes vitamins and minerals from foods.
22. Milk cures syphilis.
23. Teen-agers generally need more Calories than adults.
24. Foods should be cooked in as little water as possible.
25. If you miss breakfast, you can make up for it at the other 2 meals.
26. Brown eggs are healthier for you than white eggs.
27. As much as possible, food should be eaten raw.
28. Onions and garlic will cure a cold.
29. It is harmful to cook food in aluminum pots.
30. To lose weight, a person must eat less.
31. Peas, beans, and peanut butter are good sources of protein.
32. Dry, powdered milk has about the same minerals, vitamins, and proteins as fresh milk.
33. Margarine contains fewer Calories than butter.
34. Toast contains fewer Calories than bread.
35. Americans often get enough food, but not the right kinds for a balanced diet.
36. Large amounts of vitamin C will cure a cold.

B. CHECKING UP

When everybody has finished, your teacher will tell you what experts think about the various beliefs.

Of course if there is a good scientific reason, anyone can disagree with the experts. After hearing the quoted opinions, decide which items you disagree on and would like to discuss further.

10 CHEWING IT UP

The Activity in this chapter includes some body chemistry. You yourself are going to be the guinea pig.

Don't be alarmed! The only thing you have to do is chew.

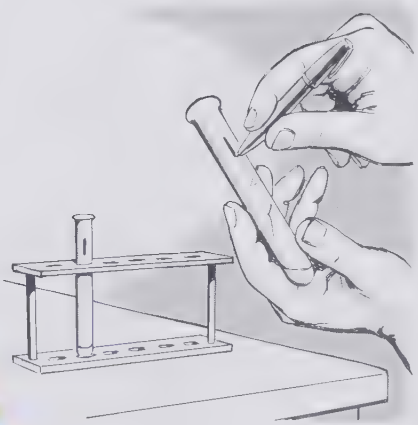
word guide

automatically	*aw-tuh-MAT-ik-lee*
enamel	*i-NAM-uhl*
gullet	*GUL-it*
mechanical	*muh-KAN-i-kuhl*

SALIVA ACTIVITY

A

Rinse your mouth well. Then chew a rubber band and collect some saliva in a beaker.



B

Divide the saliva between 2 test tubes. Label both test tubes "1."

C

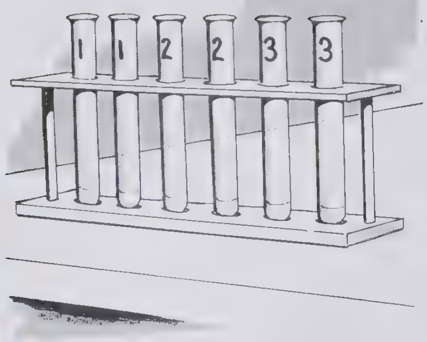
Break up half a cracker. Divide crumbs between 2 more test tubes. Label them "2."

D

Chew the other half cracker well. Do not swallow it.

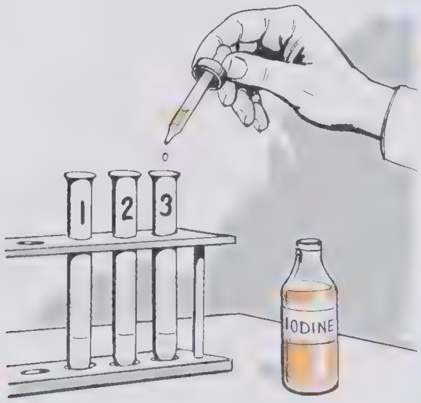
E

Collect the chewed-up cracker in 2 clean test tubes. Label them "3."



F

You now have 3 sets of test tubes.



G

Test one test tube from each set for starch. Remember that you add iodine solution and look for a blue color.

TESTS FOR STARCH AND SUGAR

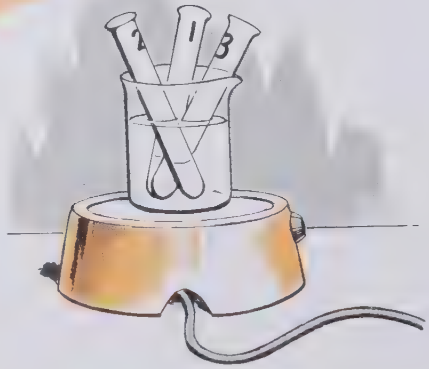
Number	Material Tested	Starch	Sugar
1	Saliva		
2	Cracker		
3	Chewed cracker		

H

Record your results in a table like this.

I

Test the 3 remaining test tubes for sugar. Remember you add Benedict's solution, heat, and look for color change. Record your results.



A. DIGESTION

1. Which of the materials that you tested contained starch?
2. Which contained sugar?
3. Which did not contain sugar?
4. Then where did the sugar come from?

You have just observed digestion. Digestion means breaking up food so that it can go through the body and get to the cells.

The starch in the cracker was digested to sugar. Sugar can get into the cells. Starch cannot.

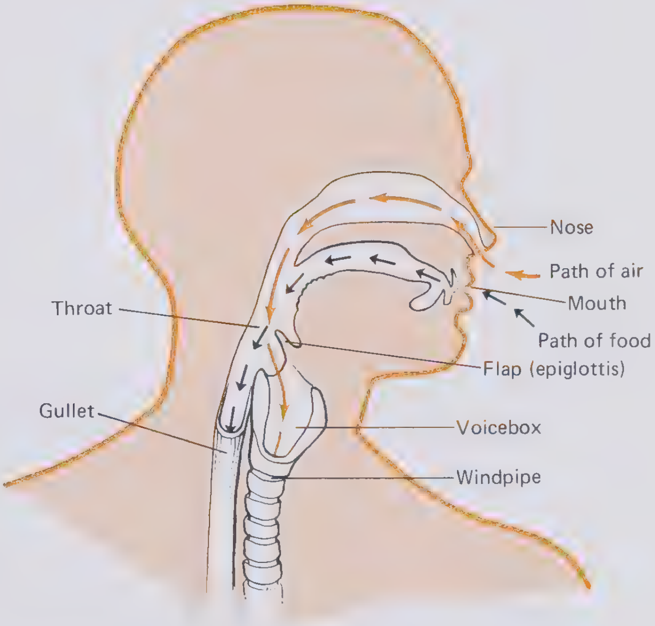
B. THE MOUTH DOES MANY THINGS

The mouth does many things besides helping you to breathe, and enabling you to talk. It also helps digestion in many ways.

First, you taste food with your mouth. You have probably noticed that the smell and taste of good food "makes your mouth water." Saliva starts flowing from the saliva glands. This helps digestion.

You chew the food. Your teeth break it up into small pieces. This is **mechanical** digestion.

Meanwhile, saliva mixes with the food. It starts changing the starch to sugar. This is the beginning of chemical digestion.



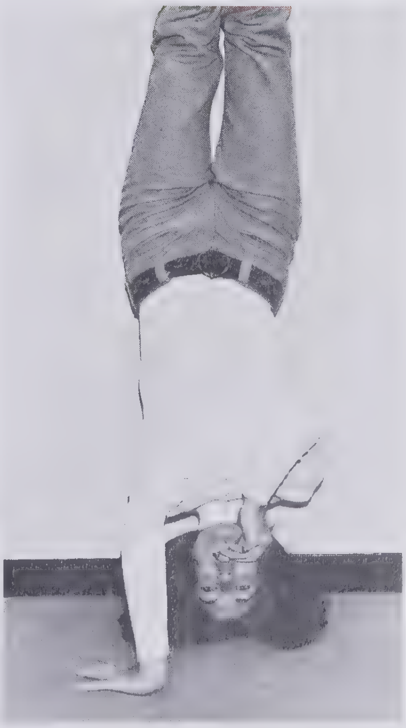
C. YOU CAN SWALLOW UPSIDE DOWN

Try it! It works! Of course, most people prefer not to eat in this position.

In the SALIVA ACTIVITY when you were chewing the cracker, it was hard to keep from swallowing. That was because when you finish chewing food into small bits, your tongue **automatically** flips it down the **gullet.** This is swallowing.

You can swallow, even when you are in an unusual position, because food is automatically squeezed through the gullet.

Sometimes you "swallow the wrong way." That means that the food goes down the windpipe instead of down the gullet. You have to cough it up. The diagram of the head shows how this can happen.

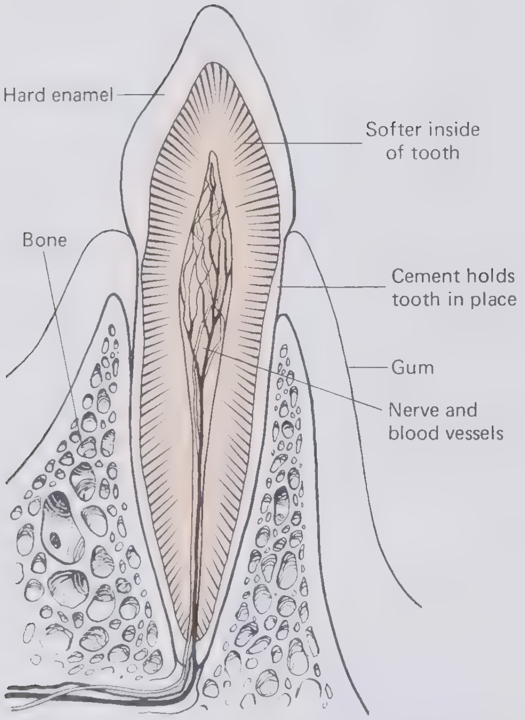


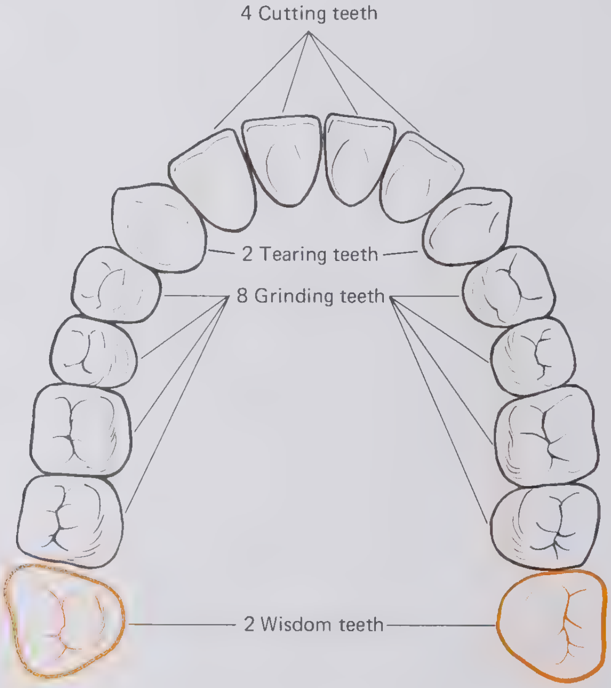
Normally you swallow the right way. When your tongue flips food backwards, the voicebox moves up against a flap and closes the opening to the windpipe. Hold your voicebox, swallow, and you can feel this happening.

5. When you swallow the wrong way, what goes wrong?

D. AND DON'T FORGET THE TEETH

As a child, you had 20 small teeth. As you grew, they were replaced by 28 larger, permanent teeth. You have 4 wisdom teeth still to come.





The front teeth are for cutting and tearing. The back teeth are grinders. Each tooth is covered with very hard **enamel.** It is softer on the inside. The teeth seem hard and tough. Actually they are very delicate. In another chapter you will see how teeth become damaged, and how they can be protected.

11 THE HUNGRY FOOD TUBE

When you swallow a mouthful of food, the process of digestion has only begun. The food now travels through the digestive system.

This is a 10-meter (32-foot) long hollow tube. It starts at the mouth and ends at the **anus.** The gullet, stomach, and **intestines** are specialized parts of the tube.

How do 10 meters of food tube fit into your body? Most of it is coiled up and tucked into the **abdomen.** Food takes about 24 hours to travel the whole length of the food tube.

word guide

abdomen	*AB-duh-muhn*
absorb	*ab-SAWRB*
anus	*AY-nuhs*
appendicitis	*uh-pen-duh-SY-tis*
appendix	*uh-PEN-diks*
intestine	*in-TES-tuhn*
pancreas	*PANG-kree-uhs*
peristalsis	*per-uh-STAWL-sis*
transparent	*trans-PAR-uhnt*

A. THE HUNTER WITH THE HOLE IN HIS STOMACH

We learned much about the food tube from the work of Dr. William Beaumont. This 19th century doctor was called to treat a hunter who had accidently shot himself in the stomach.

COURTESY OF WYETH LABORATORIES, PHILADELPHIA, PA.

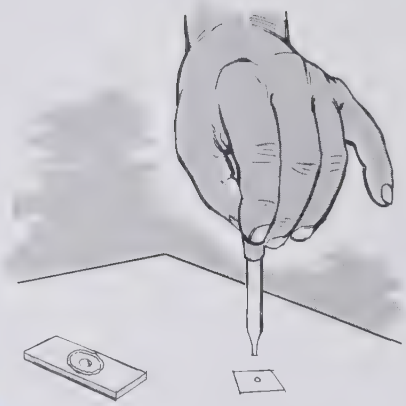
The wound healed, but left a permanent opening in the stomach wall. For 12 years Dr. Beaumont looked after the recovered hunter, and fed him experimental meals. After each meal, Dr. Beaumont looked into the stomach to see what had happened to the food.

You can do a similar experiment. Under the microscope you will look at a **transparent** little hunter called the water flea.

WATER FLEA ACTIVITY

A

Draw a very thin circle of Vaseline around the depression in a depression slide. The Vaseline will keep your slide from drying up.

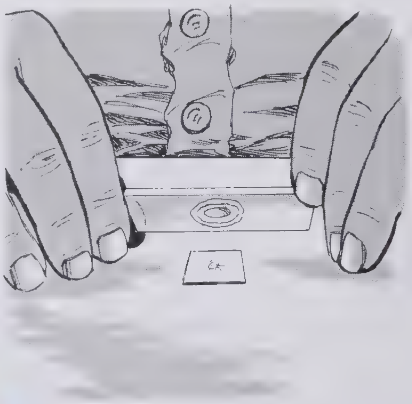


B

With a dropper, place a water flea and a drop of water in the middle of a cover slip. The food in the water is red-dyed yeast.

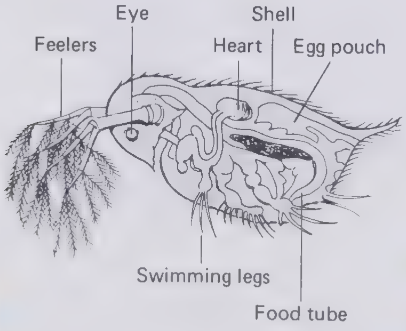
C

Add a few short threads to trap the water flea.



D

Pick up the slide and turn it over. Lower it carefully over the cover slip and press down lightly. Flip it over. The cover slip and drop of water will stay in place.



E

Examine the water flea with low power of the microscope. Watch the water flea feeding.

1. Can you see the parts shown in the picture?
2. How does the water flea feed?
3. How does food move through the food tube?

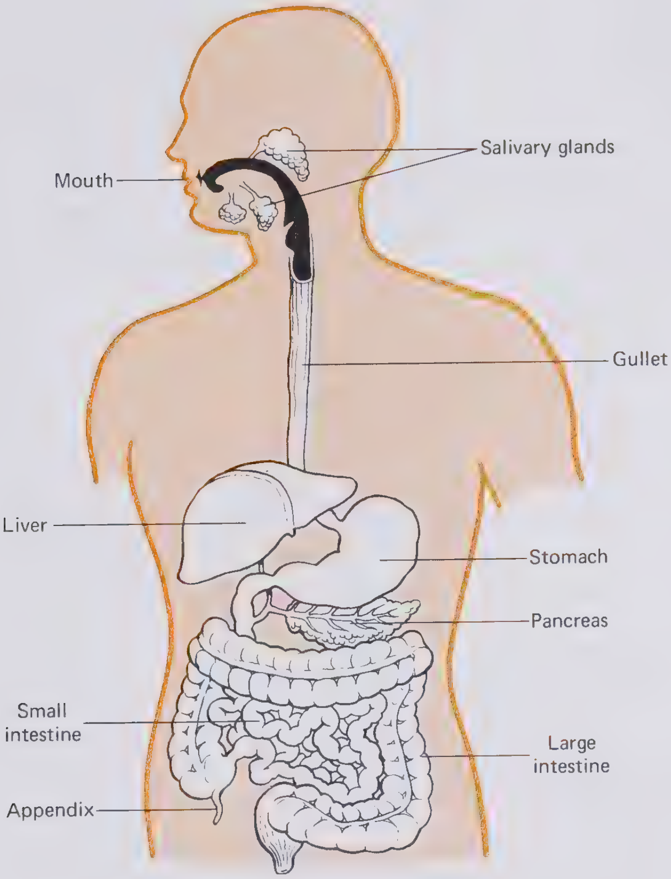
F

The red dye is an indicator. It changes color when certain chemical changes take place.

4. Did you see the food change color? Where? Explain.
5. How does the water flea get rid of waste food?

B. DOWN THE FOOD TUBE

This is the human food tube. Food is squeezed along it just as it was in the water flea. This squeezing movement is called **peristalsis.**



6. How does the water flea's digestive system remind you of the human digestive system?

The gullet squeezes food into the stomach. The food is stored here for a time and thoroughly mixed with digestive juices. Some of the protein is digested.

The stomach passes food, a little at a time, into the small intestine. This is narrow, but about 9 meters (29 feet) long—the longest section of the food tube. Digestion is completed in the small intestine. Fats, sugars, and any remaining starch or protein are chemically broken down.

The liver and **pancreas** are not part of the food tube. They are digestive glands. They pour digestive juices, something like saliva, into the small intestine. These juices work on the food.

There are many smaller digestive glands in the stomach and intestine walls which also produce juices.

C. WHERE DOES DIGESTED FOOD GO?

Food doesn't stay in the small intestine. It wouldn't do you any good if it did. The final job of the small intestine is to pass digested food into the blood. The blood then carries it to the cells.

Minerals, vitamins, and water don't have to be broken down or digested. They can be **absorbed** right into the blood and carried to the cells. The large intestine absorbs most of the water.

When a meal reaches the end of the large intestine, there is not much left except wastes. These are passed out. However, many germs have grown in the wastes. That is why human wastes must be disposed of quickly and safely.

We almost forgot something. At the end of the small intestine there is a small projection called the **appendix.** We don't know what its use is. Sometimes it becomes inflamed. When this happens it causes **appendicitis.** The appendix is then usually removed.

DIGESTIVE SYSTEM

Part	What It Does
Mouth	Breaks up food. Digests some starch.
Salivary glands	Make saliva. Send it into the mouth.
Gullet	Squeezes food from mouth to stomach.
Stomach	Mixes food. Digests some protein.
Small intestine	Digests fats, sugars, starch, proteins. Passes digested food into blood.
Liver	Sends digestive juice (bile) into small intestine.
Pancreas	Sends digestive juice into small intestine.
Appendix	We don't know.
Large intestine	Passes water into blood. Collects food wastes.
Anus	Passes wastes to outside.

7. Tell in your own words what digestion means to you.
8. List in the right order all the parts of the digestive system that food passes through.
9. What parts of the system does food not pass through?

12 JUST PASSING THROUGH

A baby crawling on the floor may pop a button into its mouth and swallow it. The next day the parents find the button in the baby's diaper. The button has passed down the food tube with no harm either to the baby or to the button.

word guide

villi	*VIL-y*
villus	*VIL-uhs*

Oh no! There were 3!

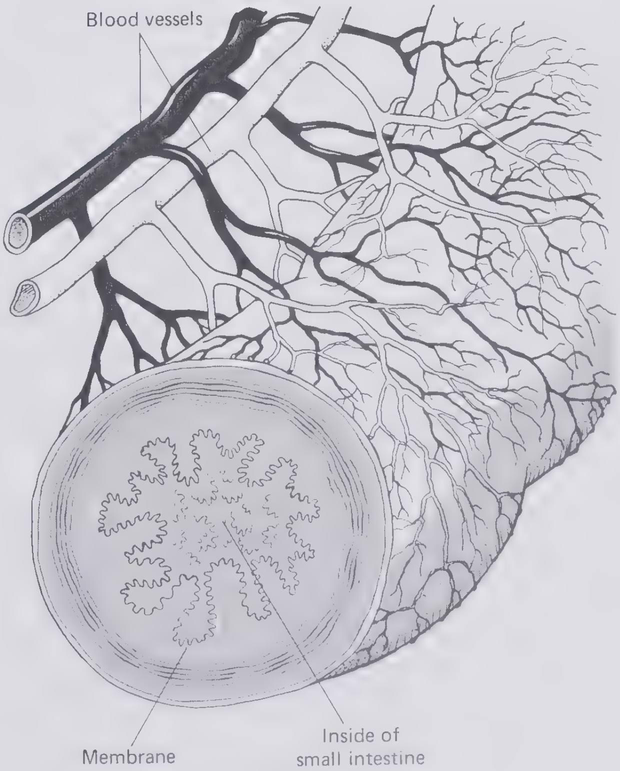
A. FROM FOOD TUBE TO CELLS

Suppose food also passed down the food tube without changing in any way. What good would it do you?

Remember that food is used in all the cells. Blood carries it to the cells. To do you any good, food has to get into the blood.

This happens in the small intestine. A delicate membrane lines the small intestine. Under this membrane there are many blood vessels through which blood flows.

Somehow, some foods can get out of the small intestine, through the membrane, and into the blood. Then it can be carried to the cells.



In the INTESTINE ACTIVITY you will see the first stage of this process—passage through the membrane.

INTESTINE ACTIVITY

A

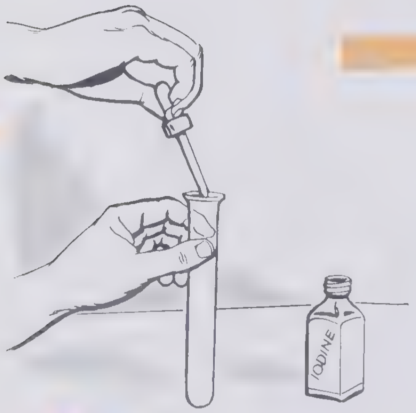
Wet a length of artificial intestine. Use a string to tie one end closed.

B

Carefully fill the "intestine" ⅓ full of starch solution, and ⅓ full of sugar solution.

C

Tie the open end without spilling the contents. Rinse the outside of the "intestine" well.



G

Wait 10 minutes. Meanwhile, find out if there is any starch in the "blood" in one of the control test tubes. (Remember the tests for starch and sugar!)

NUTRIENTS IN THE "BLOOD"

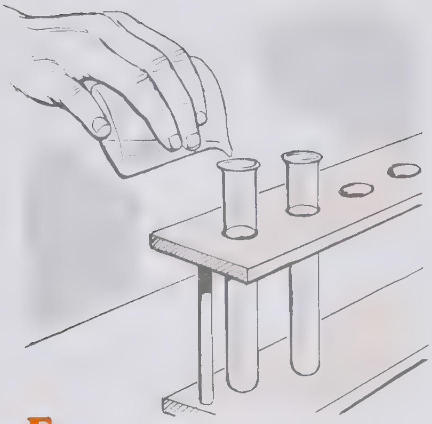
	Control Test Tubes of "Blood"	After Removing "Intestine" from Beaker
Is sugar present?		
Is starch present?		

H

Is there any sugar in the "blood" in the other control test tube? Record your results on a table like this.

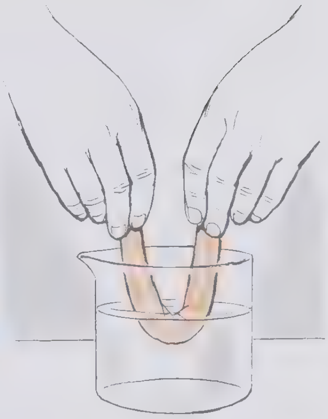
D

Fill a beaker ⅓ full of warm water. This is imitation blood.



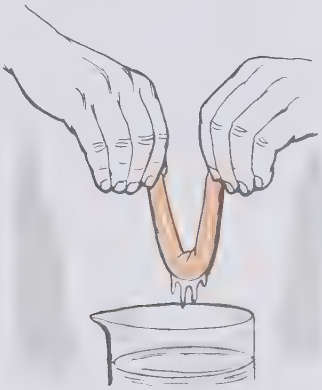
E

Pour a little "blood" into each of 2 test tubes. These will be the controls.



F

Fold the filled "intestine" and place it in the beaker of "blood," tied ends up.



I

Remove the intestine from the beaker.

J

Is there sugar in the "blood" now? Is there any starch? Record your results.

B. ABSORPTION

1. Which nutrient was able to get through the membrane into the "blood?"
2. Which nutrient was not able to get through the membrane?
3. Starch cannot be used directly by the body. Why not?
4. How is starch made useful to the body?
5. What good is digestion?

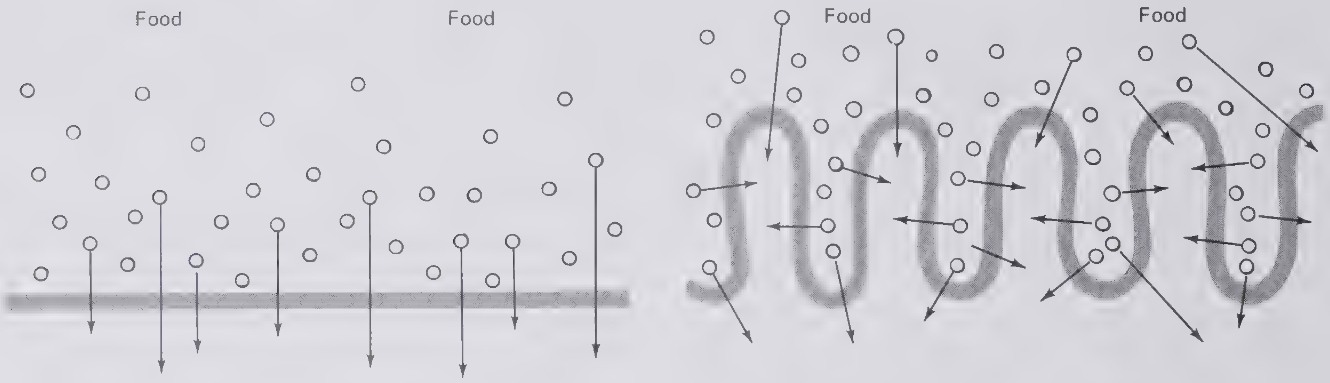
The process of materials passing through a membrane is called absorption. Food in the small intestine that has been digested can be absorbed. It is absorbed through the membrane into the blood.

There are membranes elsewhere in the body. Membranes in the mouth, stomach, and large intestine can absorb small amounts of nutrients.

Membranes in the lungs absorb oxygen. A membrane around each cell absorbs materials into the cell.

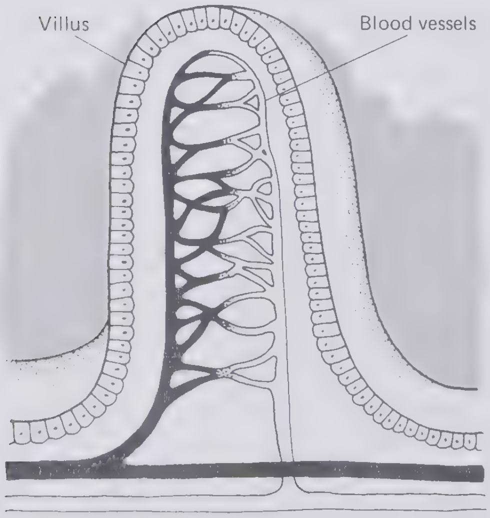
C. MORE MILEAGE FROM A MEMBRANE

Here are cross sections of 2 membranes. Which one do you think can absorb more material in 5 minutes?



The wavy membrane is more efficient because in a given space there is just more of it.

The small intestine is like the wavy membrane. Its lining is not smooth. Instead it has millions of tiny fingers that stick up. These fingers increase the surface many times.



The fingers are called **villi.** A single finger is called a **villus.** Blood vessels inside each villus carry away the digested food as it seeps through the membrane.

6. Can you list 2 characteristics of the small intestine that give it a large absorbing surface? (HINT: Remember its length.)

13 ENZYMES

Many people like to eat tripe. Tripe is the stomach lining of a cow or sheep. Look at a piece of tripe. Notice how wrinkled it is.

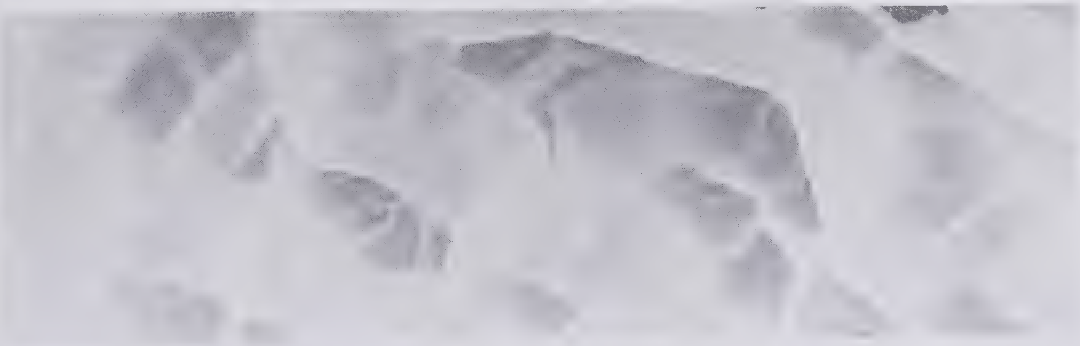
word guide

enzyme	*EN-zym*
extracted	*eks-TRAK-tuhd*
gastric	*GAS-trik*
hydrochloric	*hy-druh-KLAWR-ik*
molecule	*MOL-uh-kyool*
pepsin	*PEP-sin*
sodium bicarbonate	*SOH-dee-uhm by-KAHR-buh-nit*

Tripe

A. A PIECE OF TRIPE

In the wrinkles there are microscopic **gastric** or stomach glands. These glands manufacture a digestive juice called gastric juice or stomach juice.

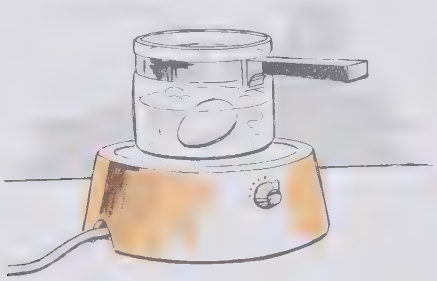


Remember that the stomach digests proteins. Something in the gastric juice is able to do this.

This something is called **pepsin.** Pepsin can easily be **extracted** from animal stomachs. You will get some pepsin.

In the PEPSIN ACTIVITY you will watch the digestion of protein.

PEPSIN ACTIVITY



A

Boil an egg for 10 minutes.

B

Cool the egg in cold water. Peel it. Separate the white from the yoke.

C

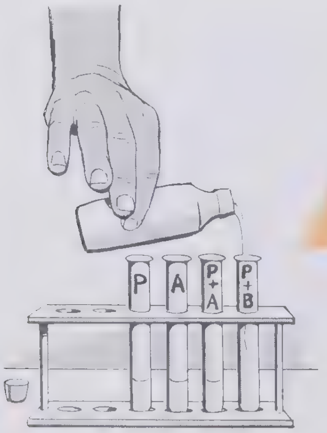
The egg white is almost pure protein. Carefully cut it into small 3 mm ($\frac{1}{8}$ inch) squares.

DIGESTION OF PROTEIN

Number of Tubes	Solution	Label
1	Pepsin	P
1	Hydrochloric acid	A
1	Pepsin + acid	P + A
1	Pepsin + sodium bicarbonate (a base)	P + B

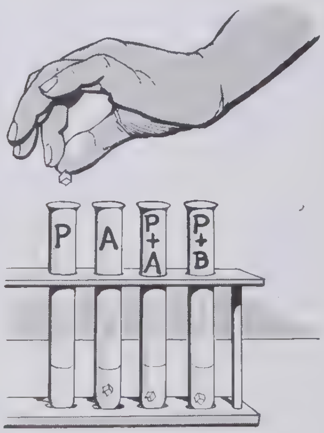
D

Label four test tubes as shown in the above table.



E

Pour about 2 cm (one inch) of the proper solution into each test tube as indicated in the table.

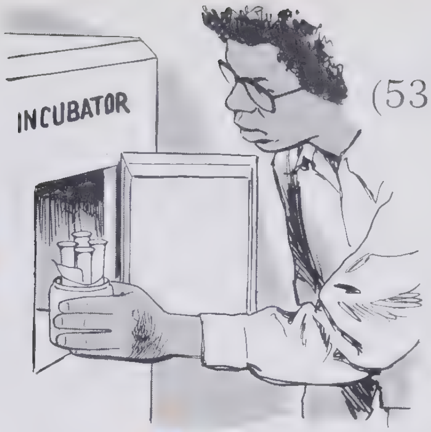


F

Place one small cube of egg white into each test tube.

G

Put a rubber band around your set of tubes. Write your name on a piece of paper and place it under the rubber band.



H

Place some of the sets of tubes in a warm place.

I

Place the other sets of tubes in a cool place.

J

After one to 3 days examine the test tubes that were kept in a warm place and in a cool place. Where the egg white has completely or partially disappeared, the protein has been digested.

DIGESTION OF PROTEIN

Tube Label	In Warm Place	In Cool Place
P		
A		
P + A		
P + B		

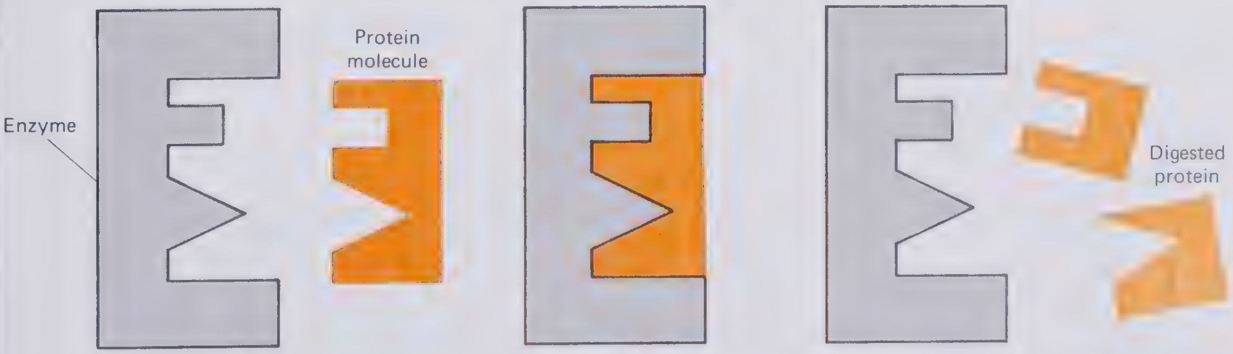
K

Copy the above table. Describe the appearance of the contents of each test tube in the table.

1. In which tube was there the most protein digestion?
2. How did pH (strength of acid or base) affect digestion of protein?
3. How did temperature affect digestion?

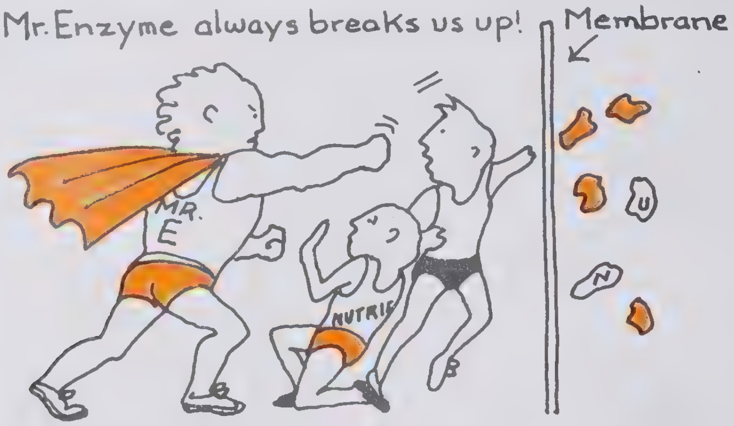
B. HOW PEPSIN WORKS

Pepsin is an **enzyme.** It can latch on to protein **molecules** like this:



Then the pepsin can break the protein down into smaller molecules.

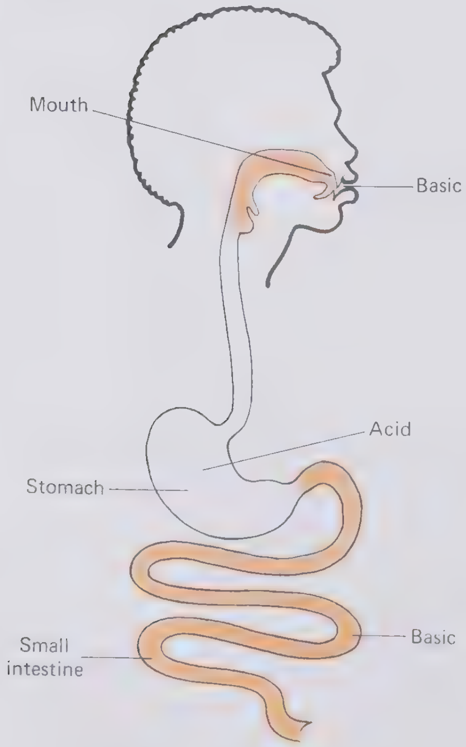
Digestive juices contain a number of different enzymes. Like pepsin, each enzyme can latch on to a particular nutrient. It digests or breaks down the nutrient into smaller molecules. Then these smaller molecules can pass through membranes and be carried all over the body.


Mr. Enzyme always breaks us up!
Membrane
MR. E
NUTRIE
U
N

Cells contain many enzymes—thousands of them. They help with other jobs besides digestion. For example, they help oxidize foods.

Try to burn a lump of sugar. It will melt and turn brown, but it won't burn. Then put a few ashes on the sugar. Light it, and it will now burst into flame.

Ashes help sugar burn outside the body. In the same way, an enzyme helps sugar burn in the cells.



C. ENZYMES ARE SENSITIVE

You can see that enzymes are important. They are also very sensitive to conditions around them.

Each enzyme needs the right temperature, not too hot and not too cold. The warmth of your body is just right for your enzymes.

Each enzyme needs the right pH. Pepsin works best in acid, and the stomach is normally acid.

However, the small intestine is basic. As soon as food leaves the stomach and passes into the intestine, the pepsin still mixed in with the food stops working. Intestinal enzymes take over digestion.

4. How did pepsin show that it is sensitive to temperature? To pH?
5. Saliva is basic. Why does it stop digesting starch when food is swallowed and reaches the stomach?

14 JOBS WITH FOOD

Because everybody has to eat, the food industry is one of the biggest industries in the country.

Bakeries, dairies, grain mills, meat packers, and canneries are all part of the food industry. They manufacture food products.

word guide

abbreviated	*uh-BREE-vee-ay-tuhd*
chemist	*KEM-ist*
classified	*KLAS-uh-fyd*
delicatessen	*del-i-kuh-TES-uhn*
industrial	*in-DUS-tree-uhl*
sterilize	*STER-uh-lyz*

DOLE PHOTO

Processing pineapples

Food is sold in groceries, supermarkets, **delicatessens,** and vending machines.

Food is cooked and served in restaurants, cafes, luncheonettes, hotels, hospitals, schools, drive-ins, and pizza places. **Industrial** feeding companies serve meals in factories, schools, and hospitals.

A. JOBS AVAILABLE, SKILLED AND UNSKILLED

The enormous food industry provides over 4 million jobs.

The jobs vary in skill and training required, and in salaries paid. Beginning jobs for unskilled workers include janitor, busboy, and dishwasher.

Top jobs in skill or training, and in salary, are those of chef, food **chemist,** food technologist, and salesperson.

INSTITUTE OF FOOD TECHNOLOGISTS

Dr. Lloyd A. Hall was a pioneer in food chemistry and technology. He developed a better curing process for bacon. He invented a way to **sterilize** foods and medical supplies with gas. Space missions use this new method of sterilization.

B. FINDING THE JOB

Right now, you may be interested in getting a part-time or summer job. However, to get a job, you first have to find it. One way is to look through the **classified** ads in the daily newspaper. On the following pages are samples of classified ads.

Classified ads are often written in a strange, **abbreviated** language. The FOOD JOB WORKSHEET will help you to understand this language.

Food Job Worksheet

1. The following abbreviations appear in classified ads. Find out from the ads, or from a dictionary, what each abbreviation means.

appt.
attr.
eve.
excel.
ex.
gd. sal.
hr.
lt.
M
M/F
mo.
nec.
per hr.
rel.
sal.
wk.
yr.
+

2. Pick one or 2 jobs that interest you at each training level. Complete the following table in your notes.

TRAINING LEVEL	JOB	YEARLY SALARY
High school not required		
High school		
Job training after high school		
Junior college		
Four year college		
College + 4 additional years		

3. In your notes, list jobs at each of these yearly salary levels.

$20,000 or more
$10,000
$ 8,000
$ 6,000
$ 4,000
$ 2,000

4. From the following ads, pick a business that you would like to buy. In your notes record:
   a. The name of the business
   b. A brief description of the business
   c. What you need in order to buy it
   d. How much money you could expect to make from it
   e. How you would run the business

The Evening and Sunday Record

CLASSIFIED WANT AD SECTION

Employment Agencies

PAUL AGENCY
—NAPH GOOD—
65 N. 40 St. 761-4745

Most positions fees paid or negotiable

Hotel Mgr: resort property	$25M
Supvsr: restaurant, chn.	$18-25M
Proj Engineer: build rests	$18M
Rest. Mgr: steakhouse	$12-18M
Chef: Jewish restrnt	$300
Saucier: nites, French rest	$300
Rest Mgr: prestige E. Side hse	$12-15M
Banquet Mgr Asst: nearby	$250+
Rest Ast: Poplr $ Franchise	$12M
Mgr: counter style rest, 5 d	$8-13M
Club Mgr: bev. exp., no kitch	$9-12M
Prodn Mgr: airline	$12M
Controller: career oppty w/chn	$12M
Chef: yr. round rest, L.I.	r & b+$225
Steward-Cntrllr: vol. rest	$225
Chef kosh, hosp, 5 day	$10.4M
Bank cafet Assts Mgr: 5 d	$9100
Kitch Steward: LI rest	$150-200
Chef Mgr: 5 d, Inplant cafet	$175
Hostesses: expd, several	to $150

MALES AGENCY
343 Glen St. 267-2514
U. HAROLD MALES

Chef Country Club R & B	$350
Chef Rstrnt, Pa. R & B	$275-300
Cooks (2nd) Country Clubs R & B	to $250
Steward Mdtn Rstrnt Hvy exp	$225
Cooks-Broilers Many Openings	
Maitre D Yacht Club R & B	$175 Wk
Cooks Country Clubs R & B	to $200
Bartender French Restrnt, French or Italian Speaking, E. Side	$130+
Waiters, Busing, Many Open'gs	

DIRECTOR, QUAL. CONTROL
Maj. fd. processor-Superv. lg. staff Froz. or Canned exp. nec . . to $22,000

OPERATIONS DIRECTOR
Midwest fast fd, franchising co. Direct Co. owned units . . . $18-22,000

SUPERMKT. BUYER/MDSRS.
Immed. need for groc., produce, and meat: byer/mdsrs. w/maj chn. exp. . . . to $25,000

RESTAURANT AGENCY

CHEF, Quality Club, Midwest	to $23M
CHEF, fine country club	to $20M
CHEF, hotel, OOT	to $18M
BAKERY Mgr, OOT	+$17M
CATERING Mgr, Motel, OOT	$ Open
CHEF, Cont Cuisine, nearby	to $15M
SOUS CHEF	to $13M
BOH MGR	to $13M
ASST MGRS	to $10M

127 W. Foster 282-0816

Help Wanted

BAKER Working Supervisor Georgia
Jewish style Bread & Rolls to $15,000
Fee & relocation expenses Paid
DEWOLFE AGENCY 150 WEST ST

Bakery Working Supvsr

To take complete charge of production for one of New England's largest retail bakery chains. Complete operation is on days. $18,000 base pay + percent of increased volume. Will pay moving expenses. Call collect, Mr. Kiehm, (312) 328-5841

BAKER — Top notch cake and pastry baker. Full time. Good wages, $200+ per wk. Call for appt. Gwen Bark Bakery. 219-887-6878

BAKERY DRIVER
Must be experienced in route work. Salary $100 per wk. plus commission for regular route. Swing routes also available. Happy's Bakery, 301 Lake-st

BAKER — Apprentice or helper for Northern suburbs.
$90 per wk 446-0800

BUSING TABLES
Nights. Steady. Transp. nec. Top pay, $100+, Toppers, 9933 N. Tulip.

CAFETERIA MANAGER
Niles Township High School. Position available immediately. 9½ month position, 6:30 a.m. 3 p.m., days, school is in session. Salary not less than $4 per hr (negotiable depending on experience). Fringe benefits. 7 paid holidays. 12½ paid sick leave days, life insurance equal to annual salary, Blue Cross-Blue Shield Group Plan, Municipal Retirement Fund. Experience and requirements: Previous experience in Institutional food service in menu planning, food ordering, forecasting, recipe development, portion control, costing, sanitation standards, employee training and taking inventories. Also supervising 13-15 employees in production and serving of breakfast and lunch to an enrollment of approx 2500 students + staff. Responsible to Director of Food Service. Apply to Ms. Jean Sklar, Director of Food Service. 783-6691, ext. 530

CAFETERIA HELP
Neat appearing men and women needed for full time work 5 days 40 hr week. Meal discount, paid vacation. Uniform furnished. $2.50 per hr. Call: 338-3488

Help Wanted

COOKS-BROILER
Expansion requires 2 cooks-broiler, 10 a. m. to 4 p. m. plus, 2 cooks-broiler 4 p. m. to 11 p. m. plus. Experienced only. Advancement opportunity to management. $200 per wk. plus. Full benefits. Paid vacations. Interviewing in person at 1528 N. Welsch

COOK — (Short Order). Barmaid-Bartender. Kitchen helper and countermen or women. Full or part time, days or evenings. Near Western Av. Can make $150-wk. Incl. bonus + tips. Call: 456-4990

COOK-SHORT ORDER
Day shift. $180 wk. Call for Interview. Nevada + Hamilton Snack Shop. Call after 4 p. m. 721-7340

COOK'S HELPER
Some kitchen exp. 9-5 p.m. $90-wk. to right person. Apply aft. 11 a. m.
Edmond's Restaurant
3 Oak Orchard rd. 731-5411

COOKS—Chefs, Grillpersons, Fry cooks. Salary $150-$200. 331-4101.

COOKS, range or broiler, to $5 an hour rounds, broiler, saute cooks, $175 Chef, Greek foods, sal. open. Broiler to $3.25. Breakfast to $3.25. Salads $120-175. All above are out of town. Need car. Local night chef. sal. open. Counter job about $115. Other food openings. **BLACK'S EMPLOYMENT,** 218 Tremont st., 532-6619

DELIVER PIZZA
For Hatfield & Son Pizzeria, 2475 N. Orange av. Contract with the largest and earn $1 + per delivery. Make 40 + deliveries daily. Must have good car w-insurance, and know north and northwest area. Full or part time. Call 253-2681

DIETITIAN Salary 9-13M
THERAPEUTIC & ADMIN.
Some light travel and/or relocate. ADA required 488-4322

DIETITIAN
Permanent full time positions available for experienced registered ADA therapeutic dietitian. Our dietrary operation handles 40 per cent therapeutic diet. Excellent starting salary and comprehensive benefit program
MILLTOWN HOSPITAL
429-6440

Help Wanted

FOOD SERVICE
Excellent job opportunity available for experienced individual to become associated with a large suburban hospital as our assistant director of food service. Successful candidate must have either of the following requirements. A 2 year Associate Degree from an accredited college or university with a major in food service management and at least 2 years of supervisory experience in a large food service operation or a high school graduate with a minimum of 2 years training in food preparation and restaurant management and 5 years of supervisory experience in large food service operation. Position offers $8M+ starting salary plus fine benefit package. Submit detailed resume including history and work experience to:
BOX 133 Post 20925

FOOD SERVICE MANAGER
Cafeteria, Bank, 5 days $175
Joe Station Agency
180 Warren

Food Service To $14K
FOOD PRODUCTION
Int'l food service organization requires for its IN-FLIGHT food division individuals capable of taking full charge of major kitchens. Successful candidates should have degree + experience. Good hospital or industrial exp will be considered. Knldge of Spanish is nec. Excellent bnft pkg & advancement potential. Call: 973-8770

FOOD TECHNOLOGIST
Food Tech. or Chemist With Knowledge of Thermal Processing of Foods. Glass Packaging. Growth Opportunity Major Co. Travel 50%, Handle Customer Liaison. Broad Benefits Including Dental Insurance. Salary in $12,500 Area. Call 348-7743

Food To $10M
HOME ECONOMIST
Food Processing Company has need for Home Economist. Must be able to assist in the development of new products etc. Prefer someone with experience in the Food Industry. Send resume to
Box 214, Times 21735

FOOD PROCESSING
Part time, full time. Men or women. No experience necessary. Education not important. Will train. Can be handicapped or foreign speaking. Unlimited opportunity for advancement
$2.50 per hr. Call 744-0041

Help Wanted

MANAGER — FOOD SERVICE

As a Management Trainee you'll enter an 8 week training program, starting with an excellent salary and extensive benefits plan. And then . . . go as far and as fast up the management ladder as your talents will allow!

Starting salary beginning at $8,320. Although a college degree or previous food experience is not required, a supervisory background, possibly military, + a high school education are essential. Enthusiasm and initiative give you the competitive edge. Openings are in the surrounding area and we encourage both male and female applicants. To explore this career opportunity call José Kogen 949-6902

QUICKY FRIED CHICKEN MGMT. TRAINEE OPPORTUNITY

WOULD YOU LIKE TO ENJOY

1. Above average earnings
2. 3 weeks vacation 1st year
3. Paid Insurance and benefit program
4. Liberal bonus program
5. 5 Day wk. unlimited advancement
6. Complete training program

If you are ambitious, hard working, resourceful, a strong capable leader. You may qualify to join our management team. You will enter highly professional training program at a starting range of $9,000 to 12,000 per year. This IS WHERE YOU START — THE REST IS UP TO YOU.

Call: Naph Parker 689-4032

MNGMT. TRAINEE OPPTYS.

Immediate openings are now available with a fast growing food chain. Complete training program, $10M+ per yr. 2 wks vacation after 1 yr, pd. hosp, pd. life insurance and 4 pd. holidays annually. For interview call 826-5000 bet. 8:30 AM and 5 PM, Monday thru Friday.

MANAGER TRAINEES FAST FOOD CHAIN

Qualifications: Can take charge and get things done, direct and motivate, cope with a wide range of activities, create when situations demand imagination, are a high school graduate, over 20 years old with ambition and desire to get ahead.

Starting at $8,000 annually with a 6 month training period after which in (2) years can reach in excess of $10,000 per year.

An Equal Opportunity Employer
Box X 6745 DIMES 1001X

MANAGER-CAFETERIA

We will train M/F with commercial cooking experience to operate modern employee cafeteria. Days, no nights or Sundays. Full company benefits. Excellent Working Environment.

Sal. $180+ per wk. Call 321-6962

FOOD MEAT Sales F/Pd $12-15M

Imported meat telephone sales. N.Y.C
HALL LAMP Agency, 25 W. 53 983-4050

FOOD Sales Trnee F/Pd $8-10M

Train in fish division. Bus. Exp.
HALL LAMP Agency, 25 W. 53 983-4050

CHEF to $15M PROFESSIONAL CHEF

For work in a research and development department in a fast growing frozen food industry. Write Box 721, Santiago, California 51334, or phone
912-862-2606

Help Wanted

NEED MEAT CUTTER

$200+ per wk.
BARRY'S MEAT MARKET
Call 843-6186 btwn. 6-8 even.

Rstrnt Hosp Dining Rm Mgr

Sal. $200 per wk. Call 398-7219

Restaurant
CAR HOPS — Days 11-7:30; Even. 7:30-1. 5 days incld Sat-Sun Guar-min. $2.50 hr. No exp. nec. Must have phone, excel. refer. Students considered only if enrolled high school. Witcha's Drive-in 6868 N. Johnson.
Call 782-8766 for appointment

RESTAURANT-KIT. UTILITY

$110 wk. Off Mon., S-F. 4-11:30 p. m. Sat. 4-1:30 p. m. Call: 827-4576

Restaurant Manager Salary 9-14M MANAGER OR ASST. MGR.

Major co. expanding in area. Some food exper. req. Co. paid fees.
JOHN JONES 868-8455

RESTAURANT $7.5-$15M MGRS/ASST MGRS

Individuals with good coffee shop, restaurant or fast foods exp. Must have good references. Prefer those who are career-oriented. Excellent benefits & advancement potential. Call: 379-2548

ROUTE DRIVERS

To deliver food products to restaurants, drive-ins, etc. Exc. salary — $10M+ benefits. Apply aft. 9:30 a. m. 3010 E. 29th-st.

ROUTE SALESPERSON — Establ route for refrig. food products. Will train. Salary $6M per yr. and comm. Call: 638-1749

FOOD SLS TRNE Fee PD To $9M + Co. Car + BONUS

Nat'l Co. needs TRNE with sm food bkgd OR sm Coll. Sell to Supmkts. B.M.L.
18 E. 141 St, Morrison Agency, 436-1859

FOOD Salesperson — We will set you up as a distributor with frozen dinners, sandwiches, pizzas, etc. Top comm Elec ovens FREE to loc. No investment req. Earn $10M+ 348-0661

FOOD SALES TRAINEES

$8,000 + Co Car + Benefits + Bonus
Must be rel. Call: 587-4952

FOOD MEAT SALES F/Pd $10-20M+

Processed meats. Major HQ accts and distributors. NY Metro area
HALL LAMP Agency, 25 W. 53 983-4050

FOOD INGREDIENTS 14-15K+

ANY sales to MEAT PACKERS, fee pd.
HALL LAMP Agency, 25 W. 53 983-4050

FOOD DAIRY Sales F/Pd $7-9M+

Quality Cheese Co. NJ retail accts.
HALL LAMP Agency, 25 W. 53 983-4050

FOOD SVCE EQUIP F/Pd 25K

Via rest equip dirs & fast food chains
HALL LAMP Agency, 25 W. 53 983-4050

FOOD PRODUCTION

Physically active, mechanically inclined. Learn food mixing. Opportunity to train for supervisor. $6M. Call: 273-3070

Help Wanted

QUALITY CONTROL FOOD TECHNOLOGIST

Position requires a degree in chemistry or physical sciences, and at least 2 yrs. experience in quality control with emphasis on statistical control of production quality. Will report to the Chief Chemist of a large food manufacturer, offering attractive benefits and $12,000+ salary. Send resume with full details of experience, education, and salary requirements.

Write MAJ 014, Post 52501
An Equal Opportunity Employer

FOOD TECHNOLOGIST Ph.D with experience, supervise quality control for a well known food processing company, M/F, $15-$20,000 yr sal., excel. benefits, send resume to Box 301, Tribune 20124.

FOOD TECHNOLOGIST experience nec., Ph.D develop new products for a large meat processing corp., $16,000+ yr. sal., attr. benefits, send resume to Box 611, Times, 10017.

SUPERMARKET-EXPERIENCED MANAGERS & ASST MANAGERS — ALSO — MEAT DEPT MGRS

This is your opportunity for a great future by joining GREENS SUPERMARKET — an expanding & growing chain. We have just contracted to open several new stores & need experienced men & women for managerial positions.

$10-25M salary & above average industry benefits

Interviews Tues, Weds & Thurs mornings

GREENS SUPERMARKET
112 Bennett Ave. (184 St)
or call 895-5600 for appt.

WAITERS, WAITRESSES

For new restaurant. All shifts available
Average $125+. Call: 279-8128

WAITRESS WAITERS

Average $150 a week. We offer free medical and vacation. Phone: 738-4757

FROZEN FOOD WRAPPERS

Earn $2.50 an hr to start. Work Mon.-Fri. 7:30 a.m.-4 p.m. Fringe benefits include meals and uniforms.

Call: 298-6890
(An Equal Opportunity Employer M/F)

WRAPPERS — Meat and Produce Dept's., Grocery clerks, Cashiers. Earn up to $3.50 per hr., M/F. Full or Part Time. SUN MARKETS.
Call: 371-2972

VENDING ROUTE PERSON

Sale and repair gum ball machines start $145 per wk. With benefits. For right person. 267-4180

CHEF & 2ND COOK — $12-20M salary, must be highly qualified in the art of fine cooking. Apply Colony, Rt. 40 Ramsey NY (501) 317-8800

DIETITIAN $140 Per Week 6 Hours Per Day 5 Days Per Week

Paid vacation and holidays, Free insurance, Free uniforms and meals. Car allowance etc. Assist modern management team in the operation of numerous industrial food services.

Call: 285-9400
BLUE VENDING
SERVICE CO.

Business Opportunities For Sale

ATTRACTIVE CAFE

3 year old cafe overlooking Charles River on well traveled US hiway. Boat ramp 2 blks. away. Lots of parking for trucks and cars. ONLY CAFE IN AREA GROSSING $40,000.00. WILL SELL BELOW GROSS AT $32,000.00.
Call: 357-4293

BAKERY — 1 person oper. $1,100. Net $400 wk. take home. $10,000. 333-4381

DONUTS and coffee shop. $2,000 per wk. short hours, hand-cut, prepared on premises, owner will teach. $10,000 cash down will handle. SMITH BUS. BROKERS 235-7500

DRIVE-IN — Hamburger, Hot Dogs, Chicken. Gross $150,000 yr. Pr. $40,000 plus.
SMITH BUS. BROKERS 235-7500

FOOD STORE — Convenient Food Store. Excel. business. $388,000 gross. $28,500 net yearly. Full inventory of stock, 3 freezer cases, 6 refrig. cases and much more. Call Today! $52,000 full price. Excellent financing available.
Call: 442-8223

ICE CREAM SHOP — Superb loc. Gross over $55,000. All fixtures, and air condrs. incld. Sacrifice at $14,500.
Call: 432-9089

GROCERY Store with meat mkt. Rent $250 mo. Gross $300,000 yr. Pr. $11,500
SMITH BUS. BROKERS 235-7500

NEIGHBORHOOD Retail Grocery Store Average $70,000 yearly gross for last 2 years. Property, all fixtures to do business, all stock and inventory. $24,500 lock-stock and barrel. Great family business. Excellent financing available. Call: 253-1148

HOT DOG BUSINESS YOU OWN IT 100%

Not a franchise. Midtown's Terrific "Best Dogs". Mobile hot dog wagon Italian sausage, pizza, chili, Polish sausage, hot foods. Gross $100 on sales of just $200 per day. 16' wagon. Completely equipped and ready for business $2,500 puts you in business. Financing available. Telephone Sunday Noon — 4 p.m. and weekdays til 6 p.m.
Call: 736-9843

HOT DOG — Hamburger-Tastee Freeze. Gross $125,000. Price $17.500.
SMITH BUS. BROKERS 235-7500

HOT DOG and BEEF stand — Located in industrial area. Annual volume $70,000. Split in partnership forces sale. Price $15,000 367-3024

LUNCHEONETTE in downtown office building, beautiful equipment, 6 a.m. to 4 p.m., 5 days. $1300-$1400 per wk. Price $18,500. 278-7668 btwn. 5-6 p.m.

VENDING machines — All locations. Coffee, mixed soft drinks, and candy. Gross $100-$150 a week. Price $5,000.
327-5600

RESTAURANT DOWNTOWN

Operating restaurant with good income. Approx. $300,000 yr. gross 8½ yrs. remaining lease — $1,500 mo. Owners retiring, require quick sale. $150,000.
Call 842-8157

15

READ THE LABEL

Much of our food comes in cans and cartons. When you buy a packaged food, do you know what it contains before you open the package, or even afterward?

You may have read an ad for the product, or seen an ad on TV. However, there is no law that says an ad must tell the whole truth about a product.

A. THE LABEL TELLS THE TRUTH

Labels are different. The Pure Food and Drug Act says that labels on food packages must be truthful.

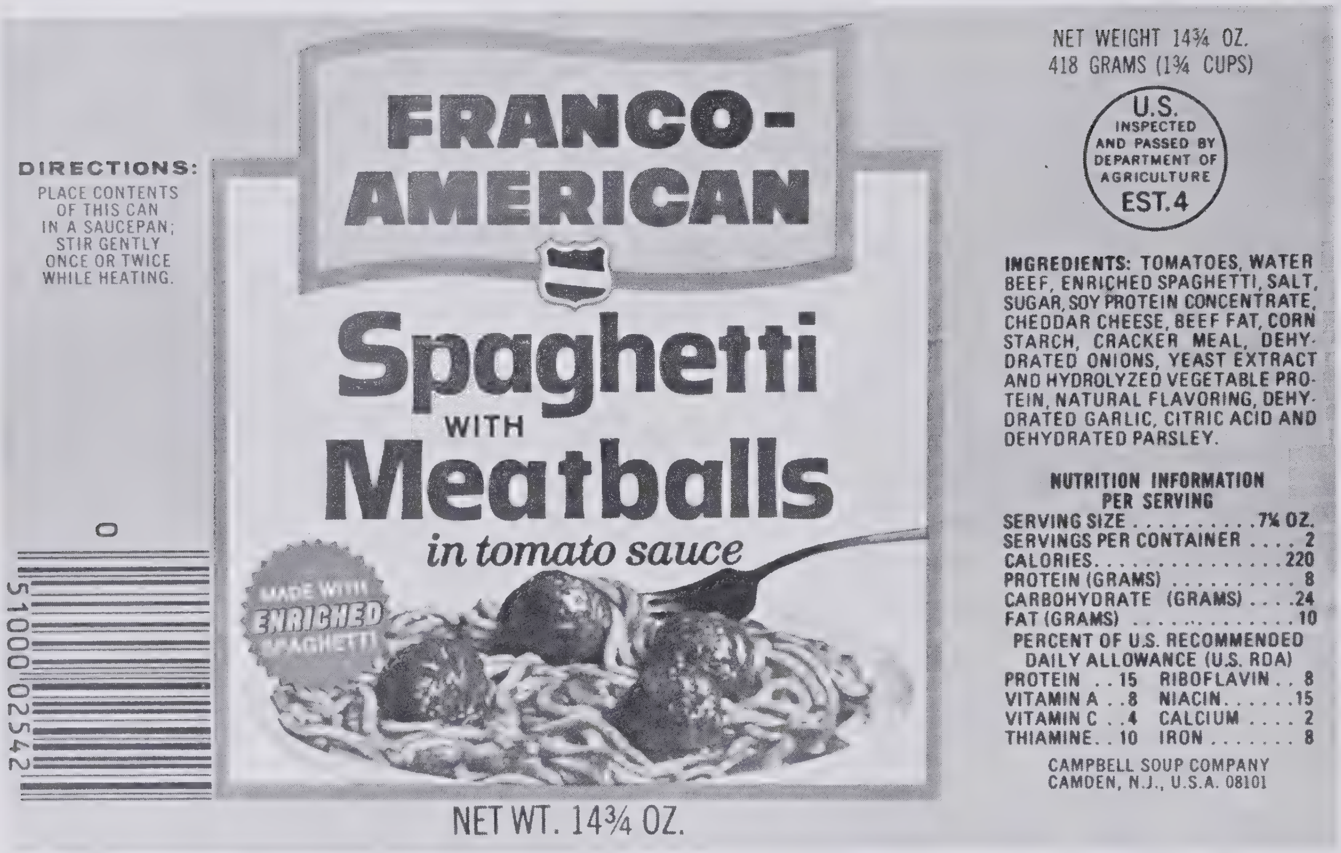
The U.S. Food and Drug Administration checks manufactured food. It makes sure that the food is properly made and that the label is accurate.

The message on the label is loud and clear. However, to get the message you have to know what to look for.

word guide

additive	*AD-uh-tiv*
calcium	*KAL-see-uhm*
caramel	*KAR-uh-mel*
disodium guanylate	*DY-soh-dee-uhm GWAHN-i-layt*
monosodium glutamate	*mon-uh-SOH-dee-uhm GLOO-tuh-mayt*
niacin	*NY-uh-sin*
riboflavin	*ry-boh-FLAY-vin*
thiamin	*THY-uh-min*

B. LOOK AT THE LABEL



DIRECTIONS:
PLACE CONTENTS
OF THIS CAN
IN A SAUCEPAN;
STIR GENTLY
ONCE OR TWICE
WHILE HEATING.

FRANCO-AMERICAN

Spaghetti WITH Meatballs *in tomato sauce*

MADE WITH ENRICHED SPAGHETTI

NET WT. 14¾ OZ.

NET WEIGHT 14¾ OZ.
418 GRAMS (1¾ CUPS)

U.S. INSPECTED AND PASSED BY DEPARTMENT OF AGRICULTURE EST. 4

INGREDIENTS: TOMATOES, WATER BEEF, ENRICHED SPAGHETTI, SALT, SUGAR, SOY PROTEIN CONCENTRATE, CHEDDAR CHEESE, BEEF FAT, CORN STARCH, CRACKER MEAL, DEHYDRATED ONIONS, YEAST EXTRACT AND HYDROLYZED VEGETABLE PROTEIN, NATURAL FLAVORING, DEHYDRATED GARLIC, CITRIC ACID AND DEHYDRATED PARSLEY.

NUTRITION INFORMATION PER SERVING

SERVING SIZE	7⅜ OZ.
SERVINGS PER CONTAINER	2
CALORIES	220
PROTEIN (GRAMS)	8
CARBOHYDRATE (GRAMS)	24
FAT (GRAMS)	10

PERCENT OF U.S. RECOMMENDED DAILY ALLOWANCE (U.S. RDA)

PROTEIN	15	RIBOFLAVIN	8
VITAMIN A	8	NIACIN	15
VITAMIN C	4	CALCIUM	2
THIAMINE	10	IRON	8

CAMPBELL SOUP COMPANY
CAMDEN, N.J., U.S.A. 08101

COURTESY CAMPBELL SOUP COMPANY

This is a can label.

1. What food product is in the can?

A company may make several brands.

2. What is the brand name?
3. What company makes the product? What is the company's address?

Net weight means weight of contents, not counting the can itself.

4. What is the net weight?

The circle is called a U.S. Shield. It is found only on meat products. It means that a United States inspector watched the entire production, and checked the safety of the product. "EST. 4" means Establishment 4. This is the factory where the meat was processed.

The ingredient statement tells what materials are in the product. The materials are listed in order of amount. The largest ingredient is listed first.

5. What is the largest ingredient? What is the next largest? Does this surprise you?

C. ADDITIVES

At the bottom of the list of ingredients on a label, items like these may appear:

monosodium glutamate
caramel color
flavoring
citric acid
BHA
BHT

These minor ingredients have little or no food value. They are called **additives.** Additives improve the flavor, color, appearance, or mouth feel of a food product. They may also help keep the product fresh.

6. What additives are listed on the spaghetti with meatballs label?

When an additive is proven harmful, the Food and Drug Administration orders it taken out of all foods.

Some people would rather not have additives in their food. You may agree or disagree. At least the label tells you what additives you are getting.

Contains: Wheat flour, whole milk, soybean meal, meat and bone meal, wheat germ meal, animal fat preserved with BHA, animal liver and glandular meal, dried vegetable pomace, baking powder, ground limestone, steamed bone meal, salt, dried corn fermentation solubles, vitamin A supplement, and irradiated brewers yeast.

Ingredients: Sugar, corn syrup, hydrogenated vegetable oil, citric acid, dextrin, gelatin, natural and artificial colors and flavors.

D. THE COMPANY HAS OPTIONS

The above items must appear on a food package label. Certain other items may also appear.

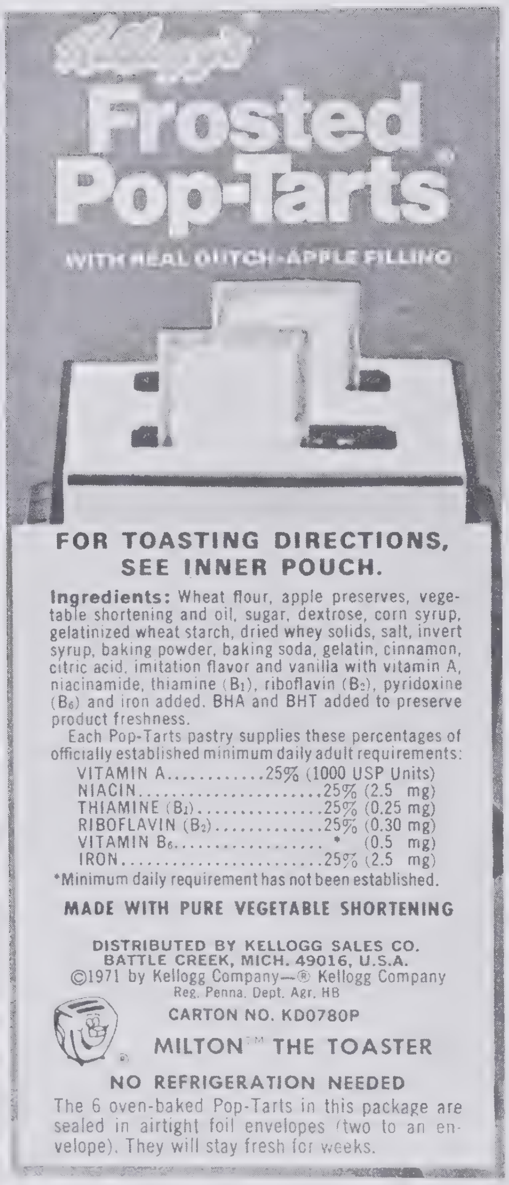
COURTESY CAMPBELL SOUP COMPANY

0 51000 02542

Computer code

The computer code is read by the store's computer, which gives prices and keeps stock records.

7. Name a label that you've seen that includes each of the following:
   a. Number of servings
   b. Serving suggestions
   c. Coupon for premiums
   d. Information about nutrition



FOR TOASTING DIRECTIONS, SEE INNER POUCH.

Ingredients: Wheat flour, apple preserves, vegetable shortening and oil, sugar, dextrose, corn syrup, gelatinized wheat starch, dried whey solids, salt, invert syrup, baking powder, baking soda, gelatin, cinnamon, citric acid, imitation flavor and vanilla with vitamin A, niacinamide, thiamine (B_1), riboflavin (B_2), pyridoxine (B_6) and iron added. BHA and BHT added to preserve product freshness.

Each Pop-Tarts pastry supplies these percentages of officially established minimum daily adult requirements:

VITAMIN A............25% (1000 USP Units)
NIACIN......................25% (2.5 mg)
THIAMINE (B_1)...............25% (0.25 mg)
RIBOFLAVIN (B_2).............25% (0.30 mg)
VITAMIN B_6................. * (0.5 mg)
IRON........................25% (2.5 mg)

*Minimum daily requirement has not been established.

MADE WITH PURE VEGETABLE SHORTENING

DISTRIBUTED BY KELLOGG SALES CO.
BATTLE CREEK, MICH. 49016, U.S.A.
©1971 by Kellogg Company—® Kellogg Company
Reg. Penna. Dept. Agr. HB

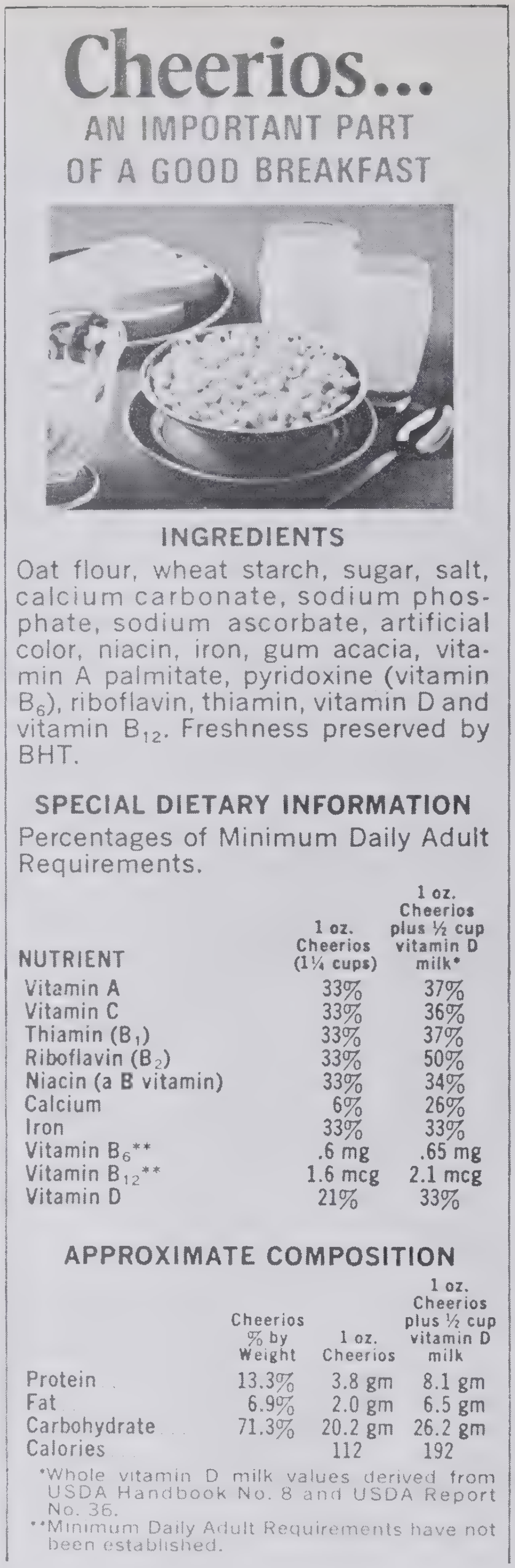
CARTON NO. KD0780P

MILTON™ THE TOASTER

NO REFRIGERATION NEEDED

The 6 oven-baked Pop-Tarts in this package are sealed in airtight foil envelopes (two to an envelope). They will stay fresh for weeks.

COURTESY OF KELLOG CO



INGREDIENTS

Oat flour, wheat starch, sugar, salt, calcium carbonate, sodium phosphate, sodium ascorbate, artificial color, niacin, iron, gum acacia, vitamin A palmitate, pyridoxine (vitamin B_6), riboflavin, thiamin, vitamin D and vitamin B_{12}. Freshness preserved by BHT.

SPECIAL DIETARY INFORMATION

Percentages of Minimum Daily Adult Requirements.

NUTRIENT	1 oz. Cheerios (1¼ cups)	1 oz. Cheerios plus ½ cup vitamin D milk*
Vitamin A	33%	37%
Vitamin C	33%	36%
Thiamin (B_1)	33%	37%
Riboflavin (B_2)	33%	50%
Niacin (a B vitamin)	33%	34%
Calcium	6%	26%
Iron	33%	33%
Vitamin B_6**	.6 mg	.65 mg
Vitamin B_{12}**	1.6 mcg	2.1 mcg
Vitamin D	21%	33%

APPROXIMATE COMPOSITION

	Cheerios % by Weight	1 oz. Cheerios	1 oz. Cheerios plus ½ cup vitamin D milk
Protein	13.3%	3.8 gm	8.1 gm
Fat	6.9%	2.0 gm	6.5 gm
Carbohydrate	71.3%	20.2 gm	26.2 gm
Calories		112	192

*Whole vitamin D milk values derived from USDA Handbook No. 8 and USDA Report No. 36.

**Minimum Daily Adult Requirements have not been established.

COURTESY OF CHEERIOS, PRODUCER GENERAL MILLS

If nutrition information is given, it must tell how much of each of these nutrients the package contains:

carbohydrate
protein
fat
calcium
iron
} these are minerals

vitamin A
vitamin C
niacin
riboflavin
thiamine
} these are B vitamins

The amount of a nutrient is often given in terms of Recommended Daily Allowance or Minimum Daily Adult Requirements. This tells how much of your day's nutrient need the package or serving provides.

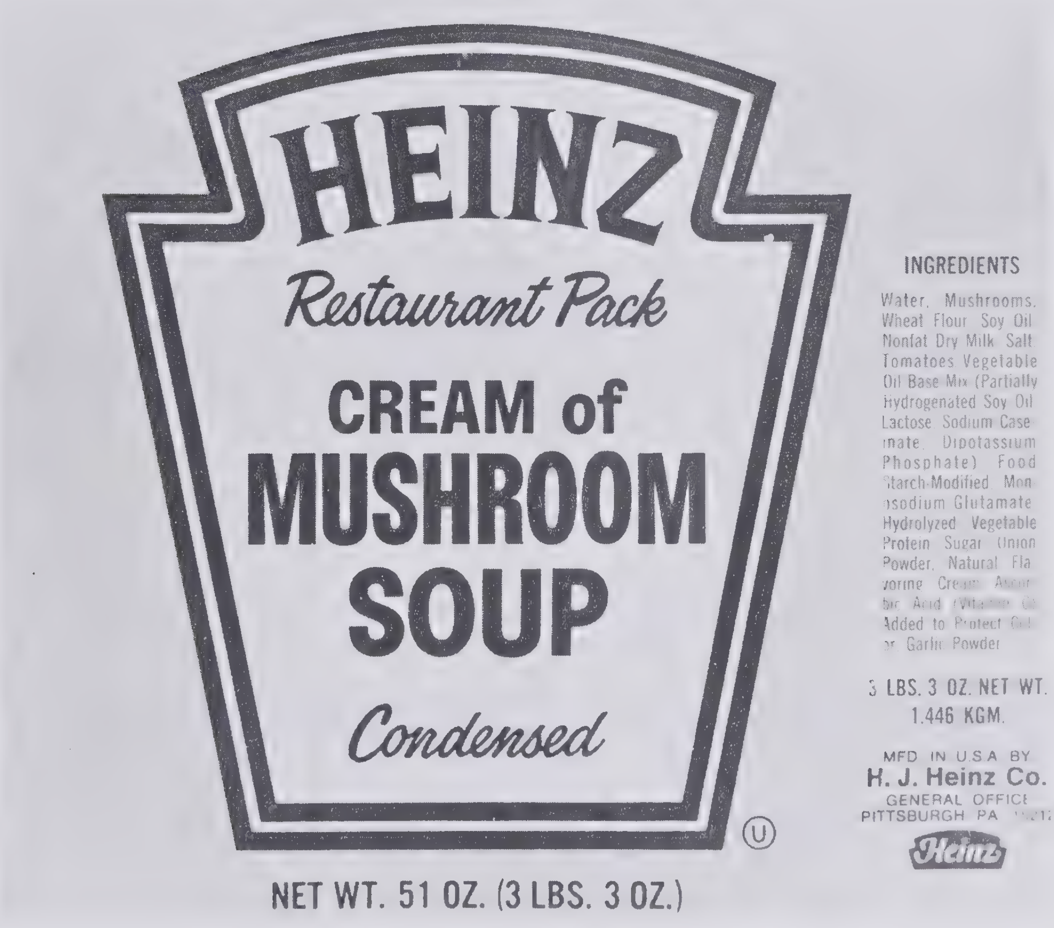
Pick a label that will help you answer these questions.

8. Name the product and list the nutrients found in it.
9. Name the product and give its approximate composition.

Price, price per unit of weight, and expiration date may also be given. The expiration date is the date after which the food should not be sold.

E. A FEW MORE LABELS

Check the mushroom soup label.



HEINZ

Restaurant Pack

CREAM of MUSHROOM SOUP

Condensed

Ⓤ

NET WT. 51 OZ. (3 LBS. 3 OZ.)

INGREDIENTS

Water, Mushrooms, Wheat Flour, Soy Oil, Nonfat Dry Milk, Salt, Tomatoes, Vegetable Oil Base Mix (Partially Hydrogenated Soy Oil, Lactose, Sodium Caseinate, Dipotassium Phosphate), Food Starch-Modified, Monosodium Glutamate, Hydrolyzed Vegetable Protein, Sugar, Onion Powder, Natural Flavoring, Cream, Ascorbic Acid (Vitamin C) Added to Protect Color, Garlic Powder

3 LBS. 3 OZ. NET WT.
1.446 KGM.

MFD IN U.S.A BY
H. J. Heinz Co.
GENERAL OFFICE
PITTSBURGH PA

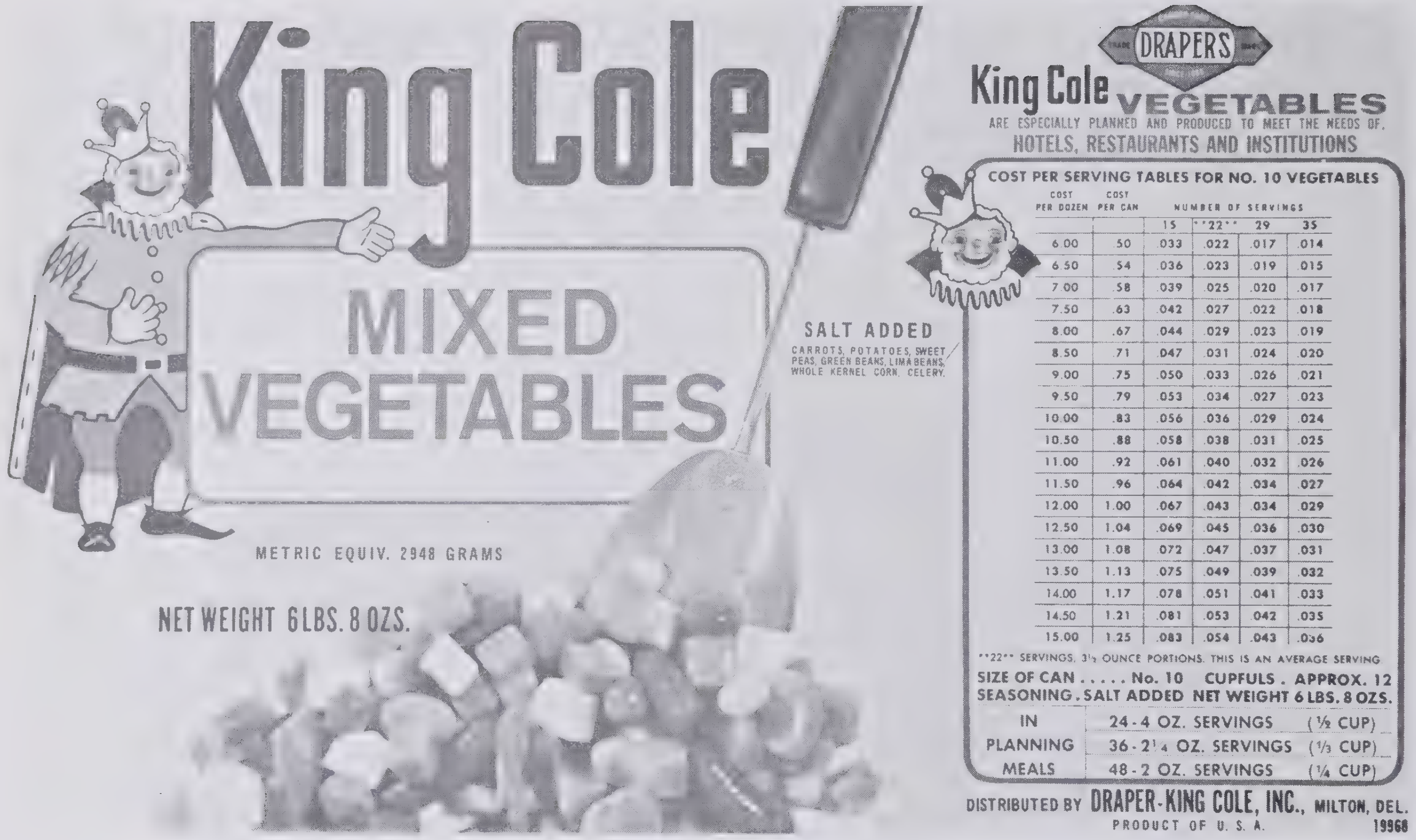
Heinz

COURTESY H. J. HEINZ COMPANY

10. What is the largest ingredient in the mushroom soup? Second and third largest?
11. Do all the required items appear on the label?

Right, there are no U.S. Shield, and no Establishment number. That means that the Heinz plant may be inspected from time to time, but an inspector does not stand by during the entire process. This is required only in meat plants.

F. BEST BUYS



King Cole

MIXED VEGETABLES

METRIC EQUIV. 2948 GRAMS

NET WEIGHT 6 LBS. 8 OZS.

SALT ADDED

CARROTS, POTATOES, SWEET PEAS, GREEN BEANS, LIMA BEANS, WHOLE KERNEL CORN, CELERY.

DRAPERS

King Cole VEGETABLES ARE ESPECIALLY PLANNED AND PRODUCED TO MEET THE NEEDS OF. HOTELS, RESTAURANTS AND INSTITUTIONS

COST PER SERVING TABLES FOR NO. 10 VEGETABLES

COST PER DOZEN	COST PER CAN	NUMBER OF SERVINGS			
		15	**22**	29	35
6.00	.50	.033	.022	.017	.014
6.50	.54	.036	.023	.019	.015
7.00	.58	.039	.025	.020	.017
7.50	.63	.042	.027	.022	.018
8.00	.67	.044	.029	.023	.019
8.50	.71	.047	.031	.024	.020
9.00	.75	.050	.033	.026	.021
9.50	.79	.053	.034	.027	.023
10.00	.83	.056	.036	.029	.024
10.50	.88	.058	.038	.031	.025
11.00	.92	.061	.040	.032	.026
11.50	.96	.064	.042	.034	.027
12.00	1.00	.067	.043	.034	.029
12.50	1.04	.069	.045	.036	.030
13.00	1.08	.072	.047	.037	.031
13.50	1.13	.075	.049	.039	.032
14.00	1.17	.078	.051	.041	.033
14.50	1.21	.081	.053	.042	.035
15.00	1.25	.083	.054	.043	.036

22 SERVINGS, 3½ OUNCE PORTIONS. THIS IS AN AVERAGE SERVING.

SIZE OF CAN . . . . . No. 10 CUPFULS . APPROX. 12
SEASONING . SALT ADDED NET WEIGHT 6 LBS. 8 OZS.

IN	24 - 4 OZ. SERVINGS (½ CUP)
PLANNING	36 - 2¼ OZ. SERVINGS (⅓ CUP)
MEALS	48 - 2 OZ. SERVINGS (¼ CUP)

DISTRIBUTED BY DRAPER-KING COLE, INC., MILTON, DEL.
PRODUCT OF U. S. A. 19968

COURTESY DRAPER-KING COLE, INC.

This label is from a big No. 10 can, used by restaurants and institutions. It has a Cost per Serving Table. Businesses often watch their pennies more closely than shoppers do.

You can compare the net weights on packages to help you find the lower price and therefore the better buy.

EXAMPLE: A 2-kilogram package of ground beef sells for $1.86. A 5-kilogram package of the same meat sells for $4.45. Which is the better buy?

$1.83 ÷ 2 = $.92 per kilogram.
$4.45 ÷ 5 = $.89 per kilogram.
The 5-kilogram package is cheaper.

12. A 15-ounce can of baked beans costs 35¢. A 25-ounce can costs 60¢. Which is the better buy?
13. A liter of milk costs 39¢. A 2-liter carton costs 78¢. Which is the better buy?
14. A 1-kilogram box of cheese costs $1.29. A 2-kilogram box costs $2.49. Which is the better buy?

THE INVISIBLE WORLD

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THE INVISIBLE WORLD

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1 THE MICROSCOPE

Most of the living things in the world are invisible. Some of these invisible beings are germs. Others are tiny animals or plants.

Trillions of such living specks dwell in the ground and in the water. They float on dust in the air. Some of them cover your body. They cover everything around you.

word guide
compound
KOM-pound
microscope
MY-kruh-skohp

This strange world can be seen only through the **microscope.** The first microscope was like a magnifying glass. It had only one lens.

A. USING THE MICROSCOPE

You are going to use a **compound** microscope in which 2 lenses work together. To see anything well with this microscope, you have to learn to use it.

The teacher will go over the parts of the microscope with you and show you how to use it.

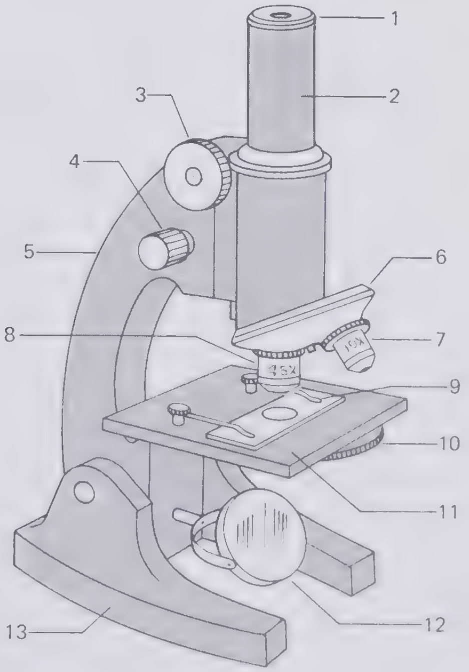
1. Identify the parts of the microscope as shown on the MICROSCOPE WORKSHEET.
2. Copy and complete the table on the MICROSCOPE WORKSHEET.

Microscope Worksheet

HOW THE MICROSCOPE WORKS

Name of Part	Function of Part
Eyepiece	
Body tube	
Nosepiece	
High power lens	
Low power lens	
Clips	
Stage	
Diaphragm	
Mirror	
Base	
Coarse adjustment knob	
Fine adjustment knob	
Arm	

Compound microscope



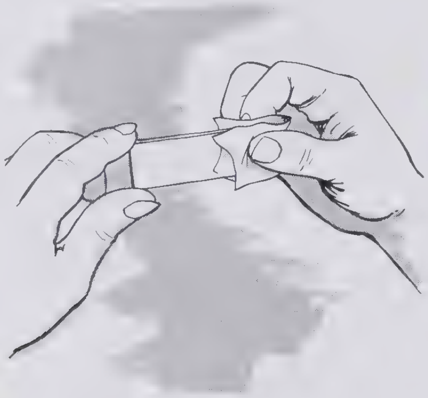
B. EVERYTHING GOES ON A SLIDE

Any object that you examine with a compound microscope must be very thin. The light has to shine through it. Therefore you mount the object on a glass slide.

In the MICROSCOPE ACTIVITY you will mount a piece of newspaper on a slide. Then you will examine the slide with low power.

MICROSCOPE ACTIVITY

MAKING A SLIDE

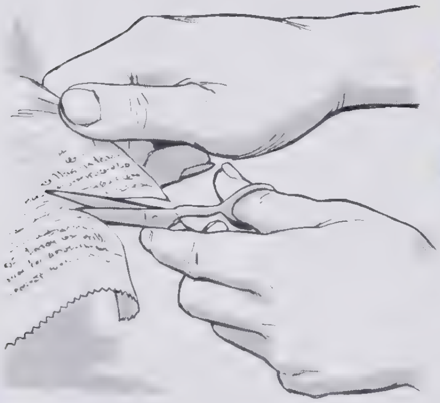


A

Use water and lens paper to clean a slide.

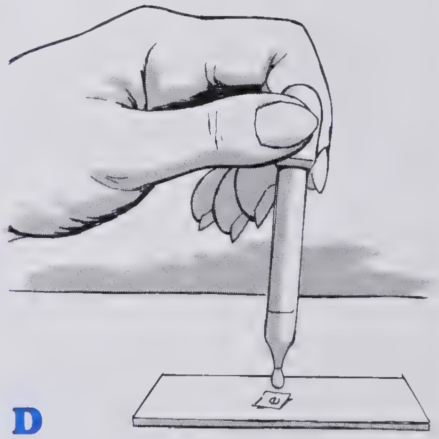
B

Also clean a cover slip.



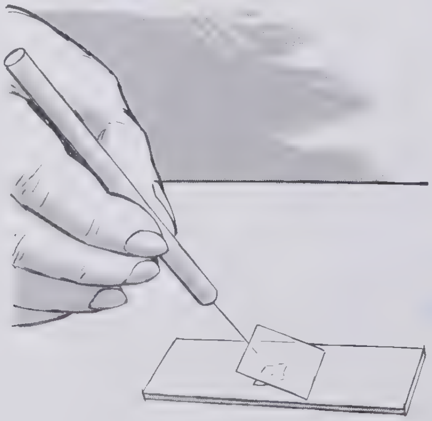
C

Clip out of a newspaper a 5 mm (1/4 inch) square containing the printed letter "e." Place the "e" in the middle of the slide.



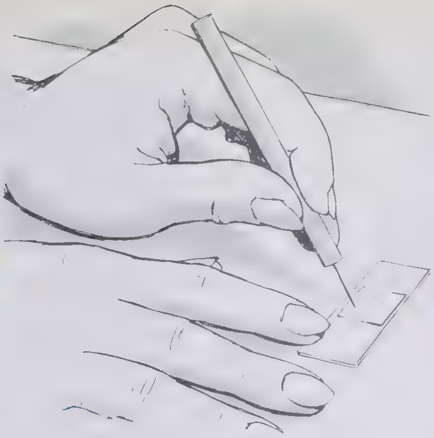
D

Add a drop of water. Don't touch the dropper to the paper. Why?



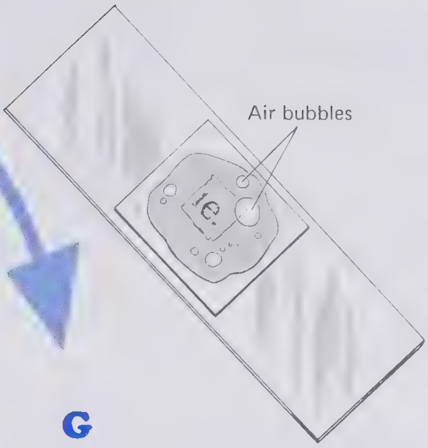
E

Add the cover slip. Lower it into place.



F

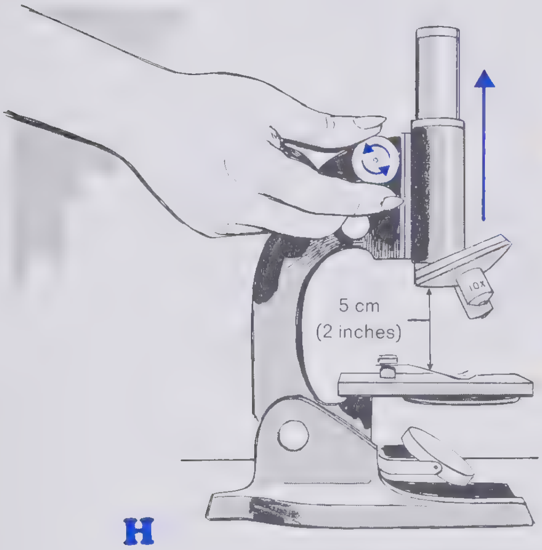
Press the cover slip gently to get rid of air bubbles.



G

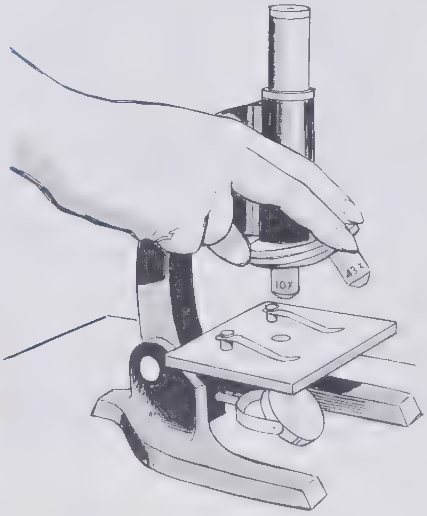
Air bubbles look like this.

FOCUSING WITH LOW POWER



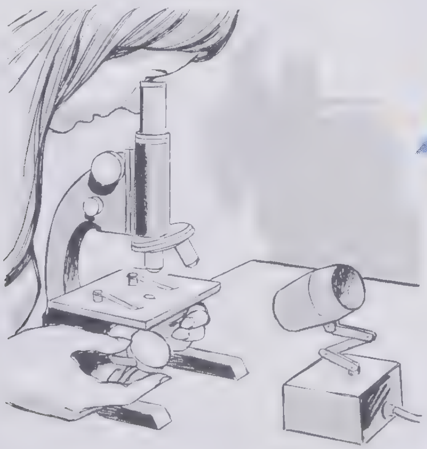
H

Take your microscope. Use the coarse adjustment to raise the body tube up 5 cm (2 inches).



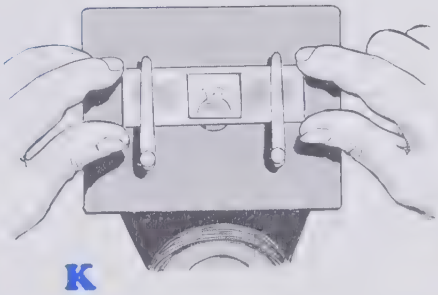
I

Click low power lens in place.



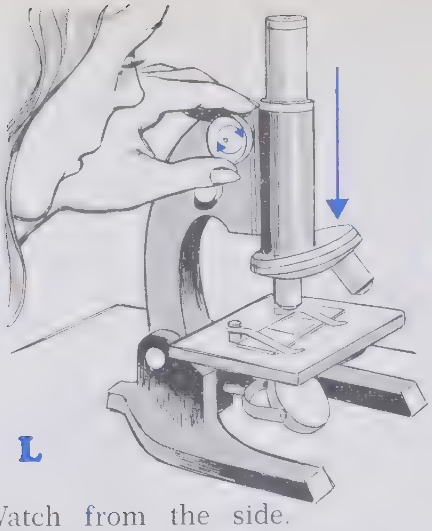
J

Look through the microscope. Aim the mirror at a lamp. Adjust mirror and diaphragm until you see plenty of light. Never use direct sunlight.



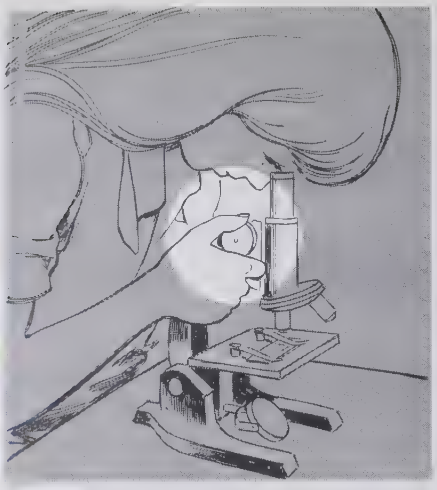
K

Place the slide on the stage. Hold it with the clips.



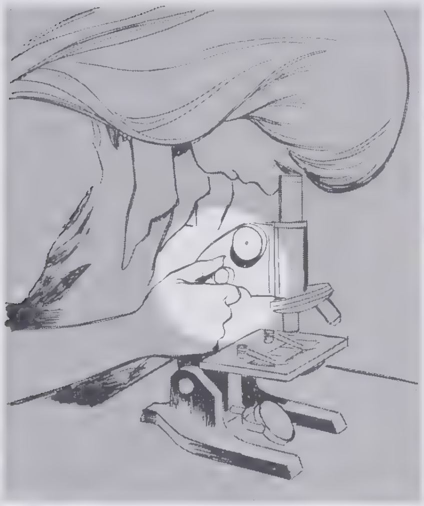
L

Watch from the side. Slowly lower the body tube until you reach a stop.



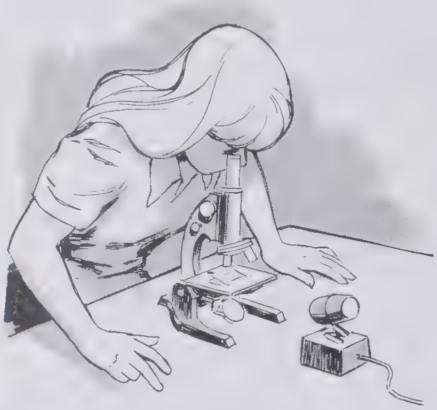
M

Look through the microscope. Slowly focus up with the coarse adjustment until the object comes into focus.



N

Finish focusing with the fine adjustment. If you lose the focus, go back to step "L."

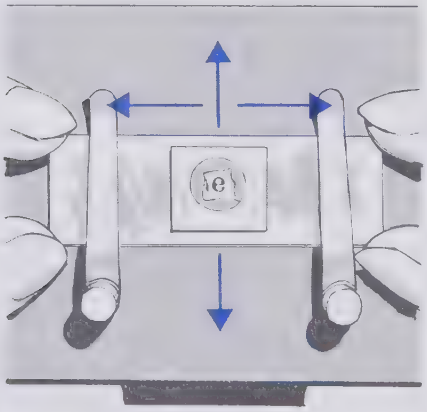


O

Examine the paper and the printed letter "e."

3. What does the printed letter "e" look like under the microscope? Draw it.

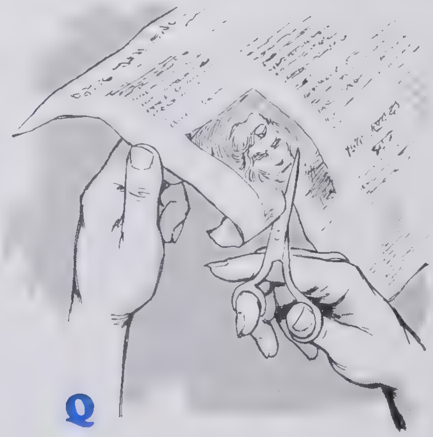
4. What does the paper look like?



P

Move the slide toward you. Away from you. To the right and to the left.

5. When you move the slide in one direction, how does the object seem to move?



Q

Make a slide of part of a photograph from a newspaper. Examine it with the microscope.

6. What is a printed photograph made of?

2

HIGH POWER OPERATOR

A microscope makes small things look bigger. It **magnifies** them.

Thus it lets you see what normally would be invisible. It lets you see details in tiny visible objects.

Different microscopes magnify different amounts. An **electron** microscope can magnify a million times (1,000,000×). It doesn't use light. Instead it uses streams of electrons, like a television picture tube.

A. USING HIGH POWER

Your compound microscope uses light. It magnifies much more with the high power lens than with the low power lens.

The high power lens is more difficult to use. Still, if you follow directions carefully in the HIGH POWER ACTIVITY, you will learn how to use it.

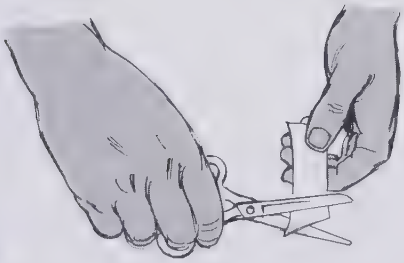
word guide

electron	*ee-LEK-tron*
glycerin	*GLIS-uhr-uhn*
magnifies	*MAG-ni-fyz*

COURTESY BAUSCH AND LOMB, INC.

New scanning electron microscope

HIGH POWER ACTIVITY



A

Make a small ink mark on a corner of a piece of lens paper. Cut out the corner.

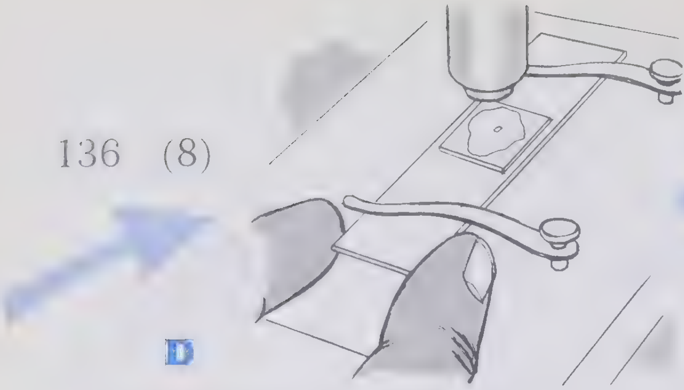
B

Make a slide of the piece of lens paper.

C

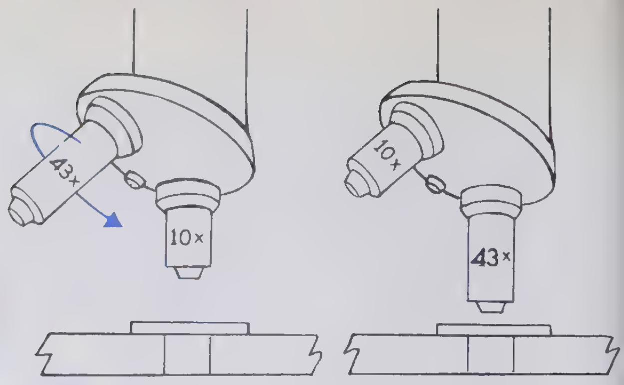
Examine the lens paper with low power.

1. What does the lens paper look like under low power?



D

The circle of light that you see in the microscope is called the field. Move a part of the ink mark that you want to examine better into the center of the field.

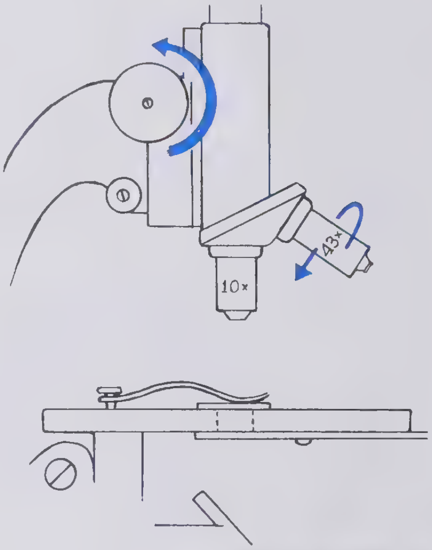


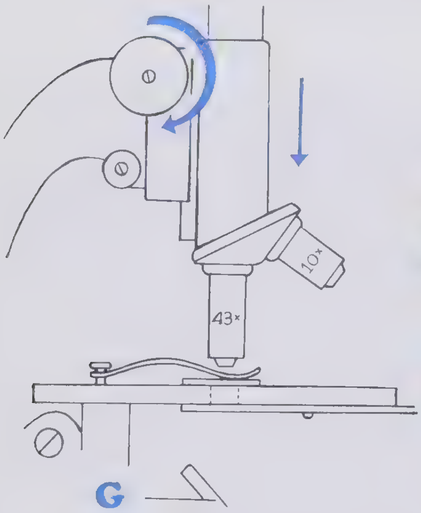
E

Ask if your microscope is parfocal. If it is, click the high power lens in place. Then go to step "H."

F

If microscope is not parfocal, raise the body tube. Click high power lens into place.





G

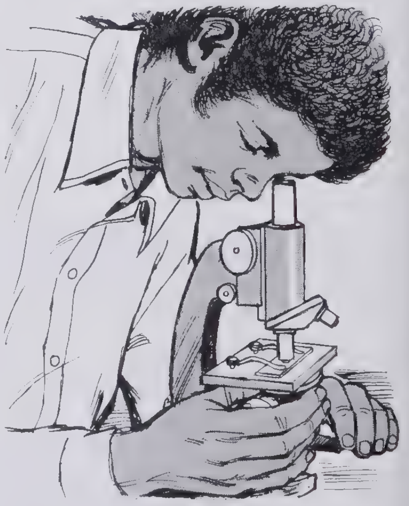
Watching from the side, carefully lower body tube until it almost touches the cover slip.

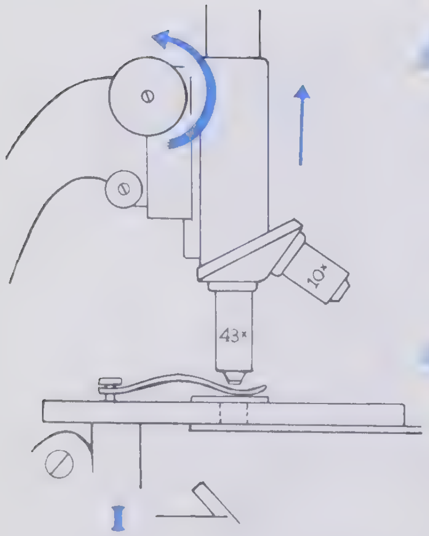
H

Look through the microscope. Open diaphragm to let in more light.

2. To switch to high power, why must you move the object into the center of the field?
HINT: How much of the object does each power lens look at?

3. With the high power, why must you let in more light?





I

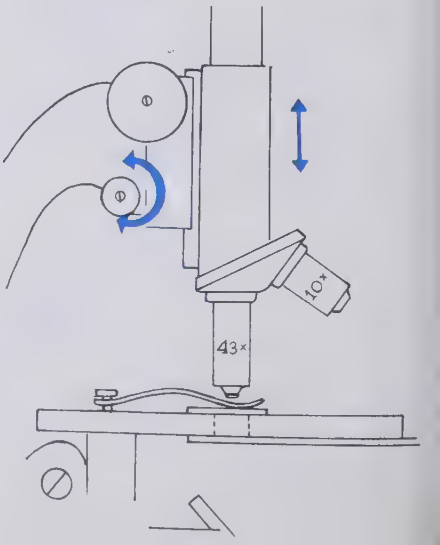
Focus up a tiny bit with coarse adjustment until paper fibers come into focus.

J

Sharpen focus with fine adjustment. Examine slide.

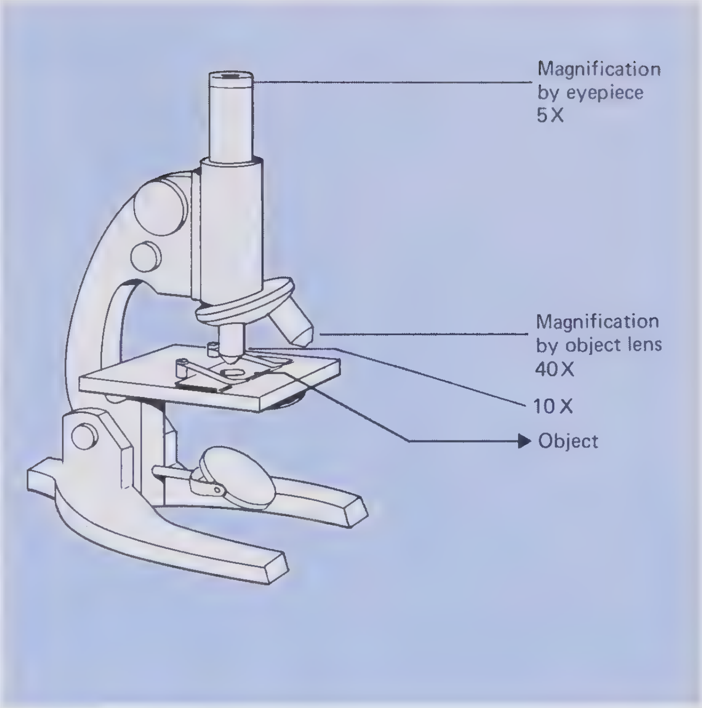
4. Compare what you see under high and under low power.

5. What seems to happen to the paper fibers as you focus up and down with fine adjustment?



B. HOW MUCH DOES IT MAGNIFY?

The object lens magnifies or multiplies the actual size of the object. The eyepiece magnifies or multiplies it again. So the magnification of the whole microscope is found by multiplying the 2 magnifications.


Magnification by eyepiece 5X
Magnification by object lens 40X
10X
Object

	Eyepiece magnification
×	Object lens magnification
=	Total magnification of microscope

Suppose the eyepiece is 5x and the object lens is 40x. What would the total magnification of the microscope be?

MICROSCOPE MAGNIFICATION

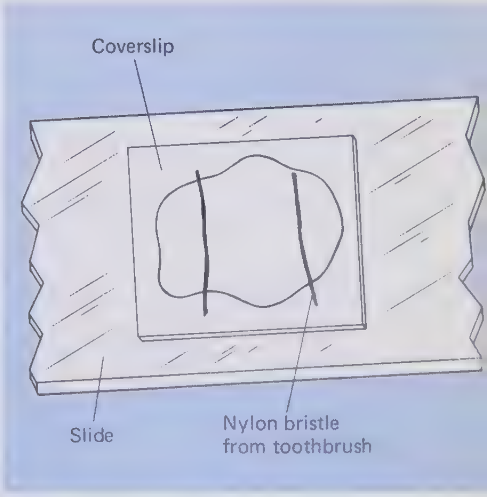
Eyepiece Magnification	×	Object Lens Magnification	=	Total Magnification of Microscope
5x	×	40x	=	200x (example)
?	×	?	=	(low power)
?	×	?	=	(high power)

Copy the TABLE OF MICROSCOPE MAGNIFICATION in your notes. Fill in the powers of your lenses. Then figure the total magnification of high and low power, like the example.

C. EXPLORING THE INVISIBLE WORLD

Make slides, and examine some of the following. Use simple drawings or brief descriptions to report what you see.

a. Some fibers from your clothing.
b. A hair. Mount it in **glycerin.**
c. Dry crystals of salt, sugar, or tartaric acid.
d. Cornstarch. Mount it in alcohol, and examine it quickly.
e. Some microfossils.
f. Living brine shrimp or rotifers. Support the cover slip with nylon bristles so the little animals won't be crushed.
g. Whatever else interests you.



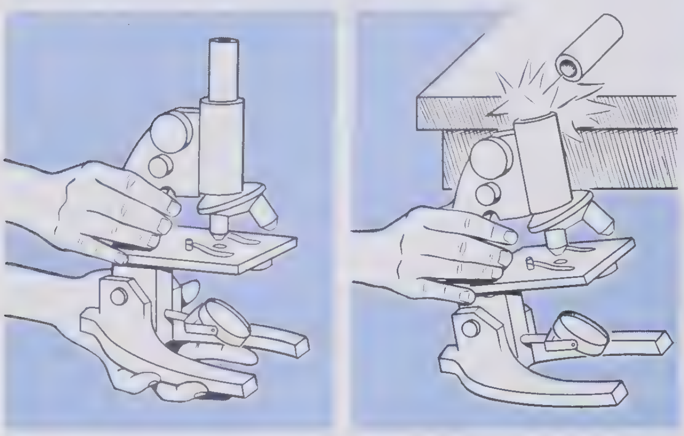
By now you should be expert enough so that you won't get hung up on the MICROSCOPE DO'S AND DON'T'S WORKSHEET.

Microscope Do's and Don't's Worksheet

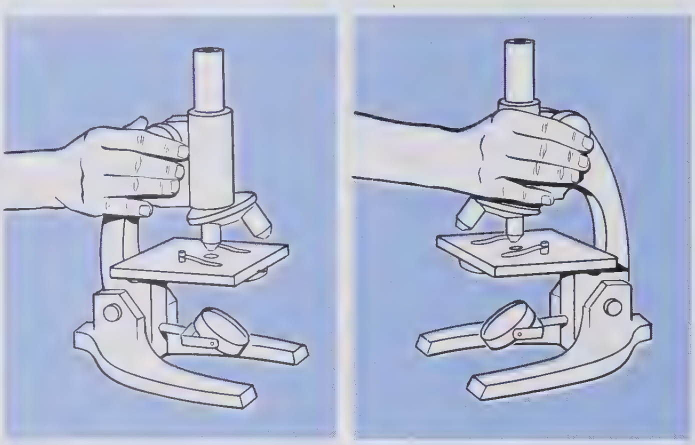
Describe the DO or the DON'T that is shown.

DO DON'T DO DON'T

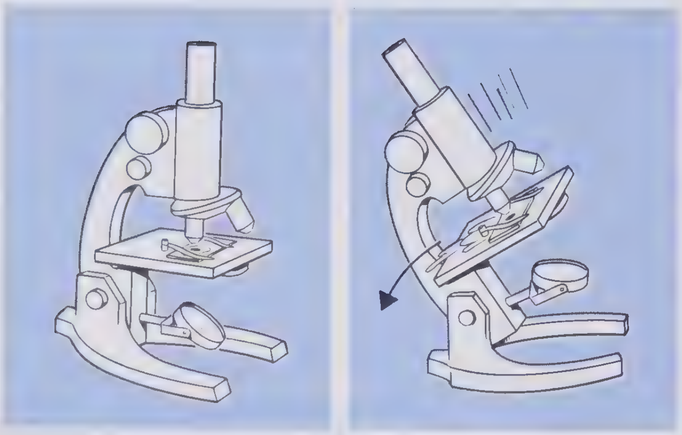
1.



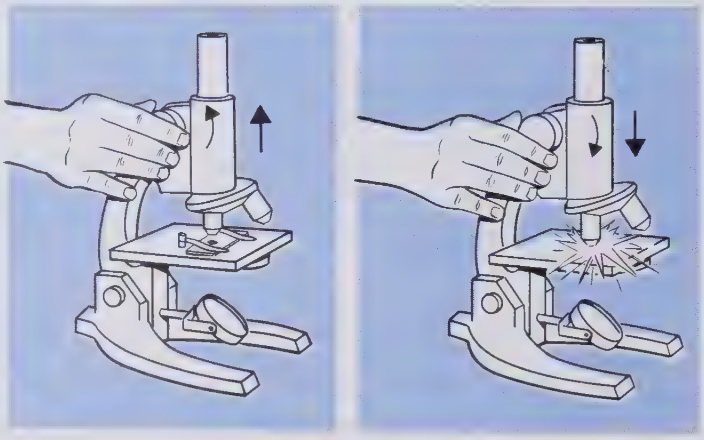
2.



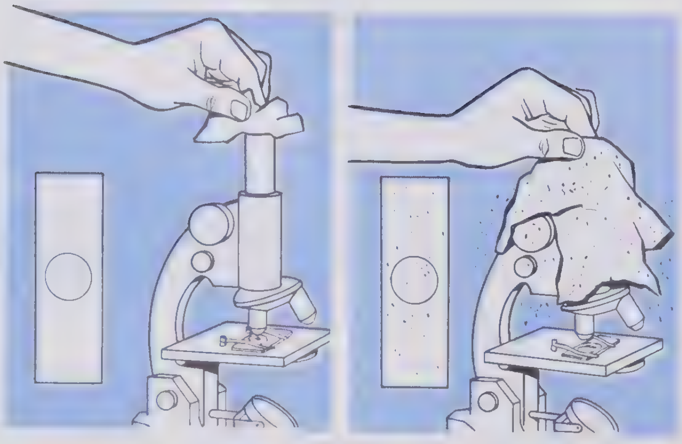
3. DO DON'T



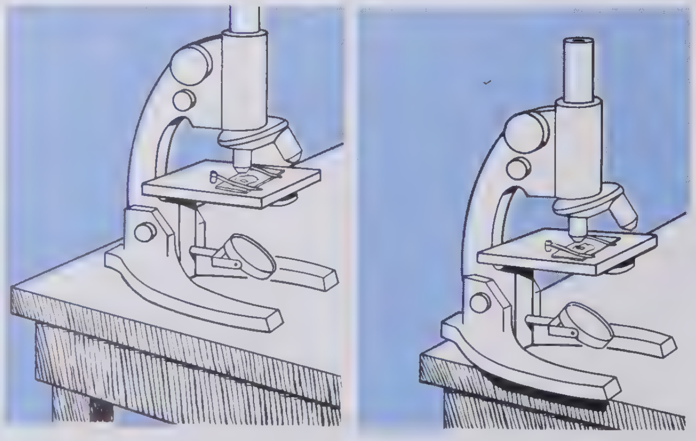
4. DO DON'T



5. DO DON'T



6. DO DON'T



3 FINGERPRINT EXPERT

Police work can be hard and dangerous. Sometimes it is dull. Often it is exciting and interesting.

We all know that police arrest criminals and direct traffic. We may not think of the other work they do. They hunt for lost children, help people in the community, and give aid at traffic accidents.

BRUCE ANSPACH/EPA NEWS PHOTO

word guide

whorl *HWUHRL*

A. KINDS OF POLICE

Most policemen and policewomen work for the city. They have to give needed help even when they are off duty.

Usually they must be high school graduates. They take an examination to get their job. The pay is pretty good.

State troopers generally patrol the highways and small towns. In many states they live in barracks.

FBI special agents must be college graduates. Many are accountants or lawyers. They train hard.

Some businesses, like factories and stores, hire special police. They protect private property from theft and damage.

COURTESY SAN FRANCISCO POLICE DEPT.

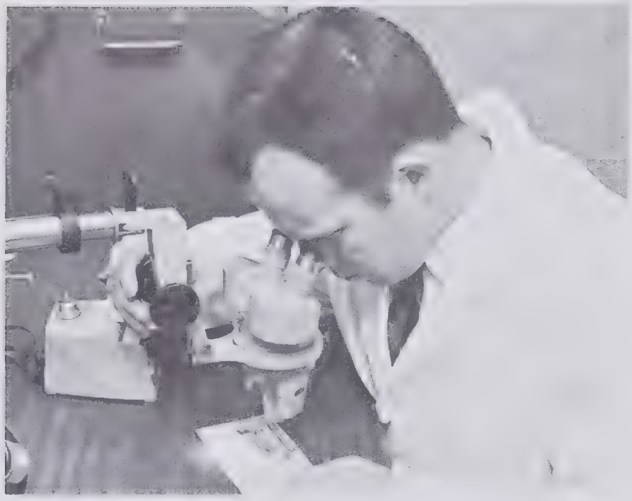
COURTESY MASSACHUSETTS STATE POLICE

POLICE DO MANY THINGS

FEDERAL BUREAU OF INVESTIGATION

B. THE POLICE AT THE MICROSCOPE

The public never gets to see some of the most important police work. This is the work that is done in police crime labs.

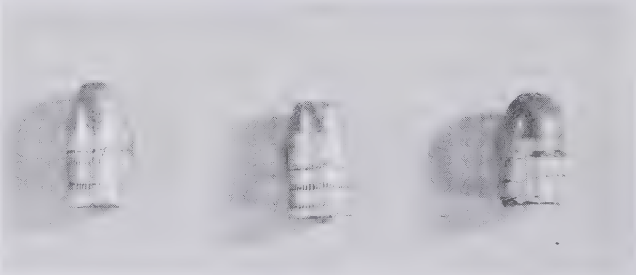

NEW YORK CITY POLICE DEPT.

In the police crime lab police chemists analyze blood and similar evidence. Others analyze handwriting.

The microscope expert is a key investigator in the lab. He or she identifies bullets, fingerprints, and scraps of material.

Every gun leaves scratch marks on the bullets that it fires. No other gun makes the same scratches.

Can you tell which of these bullets were shot from the same gun?


MASSACHUSETTS STATE POLICE

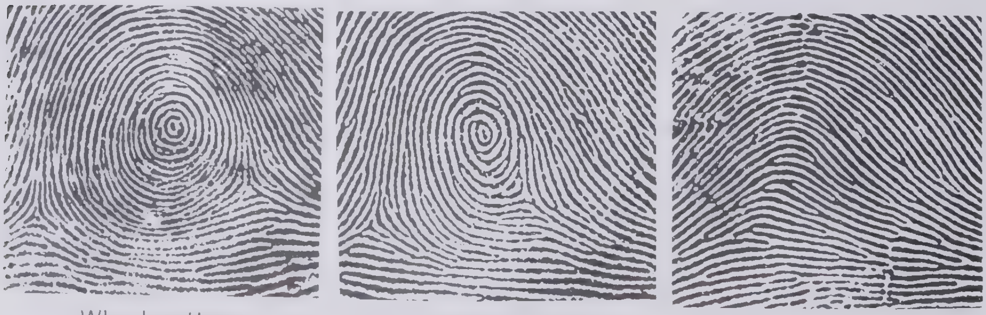
C. FINGERPRINTS

Glands in the skin produce oil. The oil forms a thin layer on the skin surface. When you touch anything, you deposit a little oil in the form of a fingerprint. No 2 fingerprints are exactly the same. However, in all fingerprints the lines form only 3 basic patterns.

In the **whorl** pattern the lines make a complete circle.

In the loop pattern the lines curve back in a horseshoe turn.

In the arch pattern the lines don't curve back.


FBI

Whorl pattern Loop pattern Arch pattern

A person's prints can be identified by noting the pattern of each of the 10 fingers.

D. BE YOUR OWN EXPERT

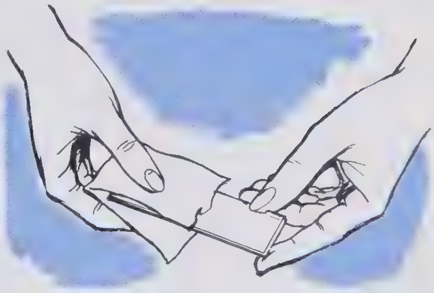
How good are you at spotting the evidence? Try it in the MICROSCOPIC EVIDENCE ACTIVITY.

MICROSCOPIC EVIDENCE ACTIVITY

FINGERPRINTING

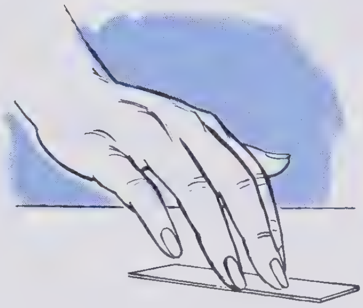
A

Clean a slide with soap and water.



B

Dry it.

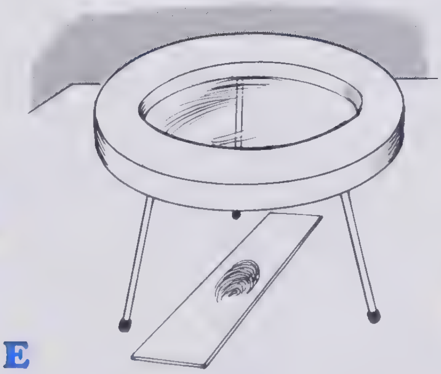


C

Place prints of first 2 fingers of one hand on the slide. Cover slip is not needed.

D

Dust prints lightly with powder. Blow off the excess.



E

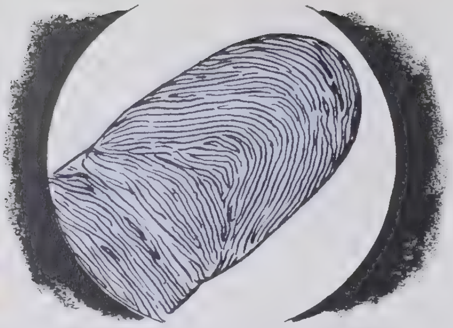
Examine the fingerprints with a magnifier. In your notes, note the pattern of each finger.

F

Examine the prints of others in your group. Record their patterns.

G

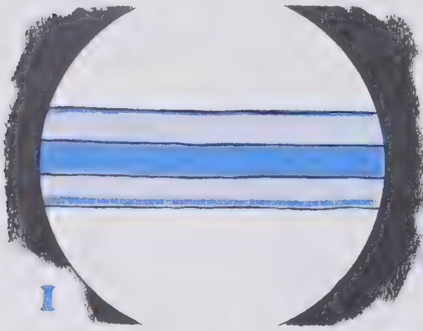
Turn your back. Have your partners give you one of the slides. Can you identify the fingerprints?



H

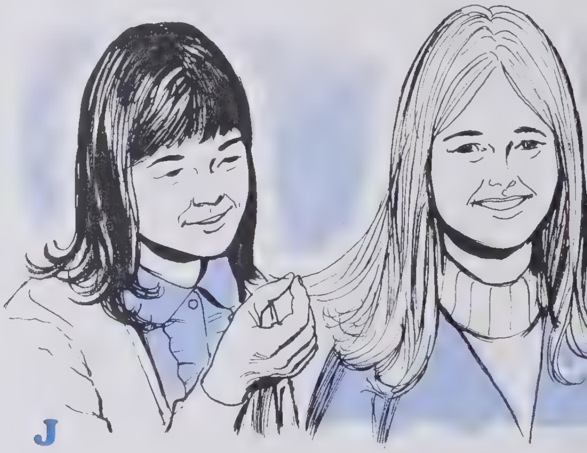
You can also see your fingerprint directly. Lay your finger on the stage of the microscope under the low power lens. Shine a lamp on it and examine the fingerprint by reflected light.

IDENTIFYING THE EVIDENCE



I

Mount a scalp hair in glycerin. Examine with microscope. Compare with an eyebrow hair.



J

Also examine some of the following kinds of hair: black, brown, blonde, red, gray, dyed, bleached.

1. Where is the color found in each hair? Make notes.

K

Your teacher will give you an envelope containing "evidence of a crime."

L

2. Can you identify the "evidence?" Use sketches and notes from earlier microscope work to help you.

4 WHAT WE ARE MADE OF

What are you made of? Put yourself under the microscope and you will see.

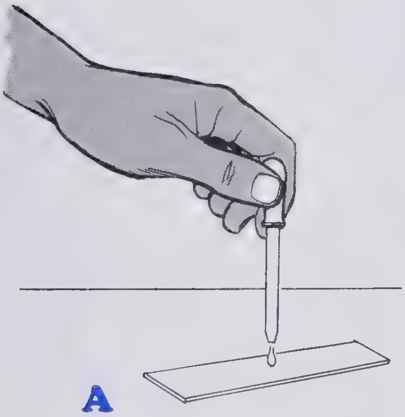
Remember, things examined with the microscope must be thin and transparent. So you have to make a thin, transparent scraping of yourself. The ANIMAL CELL ACTIVITY shows how to do this easily.

word guide

ameba	*uh-MEE-buh*
bacteria	*bak-TIR-ee-uh*
cytoplasm	*SY-tuh-plaz-um*
nucleus	*NOO-klee-uhs*

ANIMAL CELL ACTIVITY

CHEEK CELLS

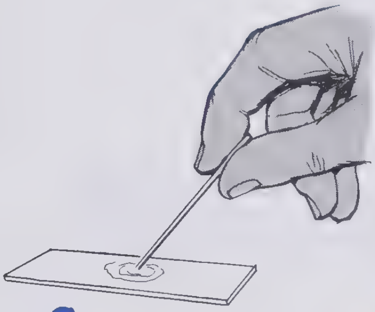


A

Place a drop of stain on a clean slide.

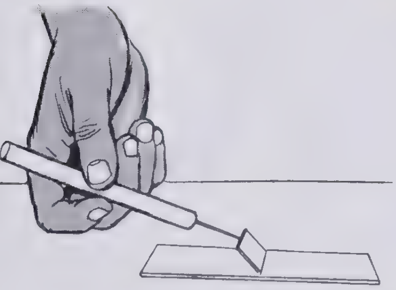
B

Gently scrape the inside of your cheek with the flat end of a toothpick.



C

Mix the scrapings in the drop of stain.



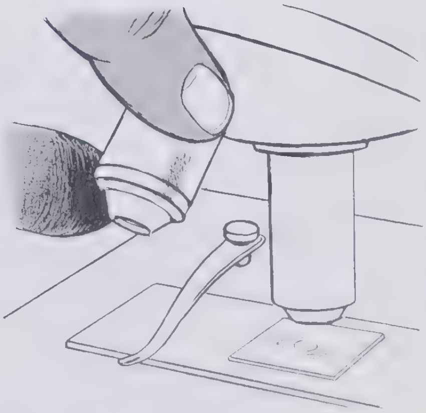
D

Add a cover slip.

E

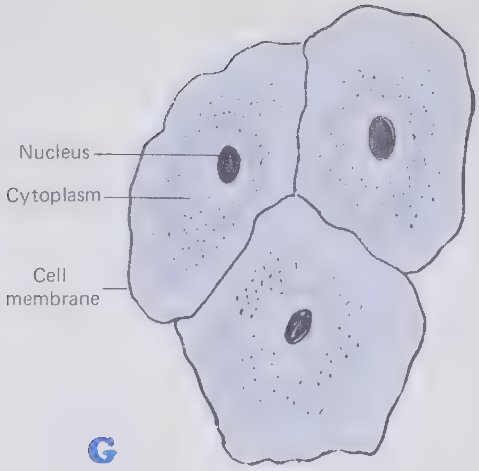
Examine the scrapings with low power of the microscope. You may have to dim the light to see much. The scrapings are clumps of cheek cells.

1. What is the shape of cheek cells?



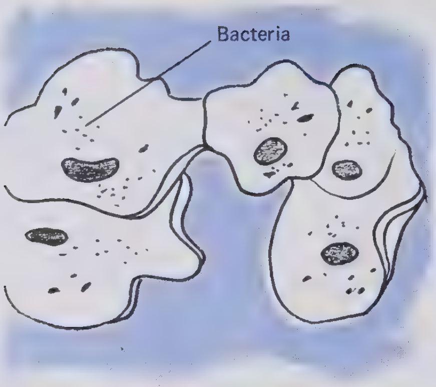
F

Switch to high power. Adjust the light again. In your notes, draw one very large cheek cell.



G

The dark staining structure in the cell is the **nucleus.** Around it is **cytoplasm.** The cell is enclosed in a cell membrane. Label these structures in your drawing.



H

The moving specks on the cheek cell are **bacteria**—a kind of germ.

2. How do cheek cells and bacteria compare in size?

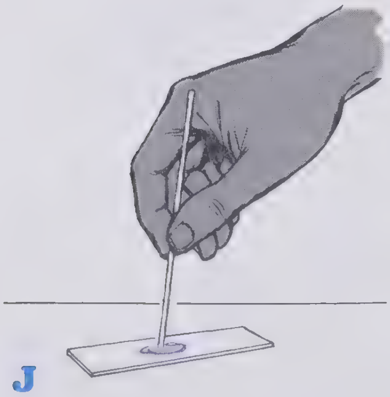
FROG CELLS

I

Frogs shed their skin in the water. Make a slide from the cloudy water in which a frog has been sitting. Find frog skin cells.

3. How are frog skin cells like human cheek cells?

CELLS IN HAMBURGER



J

Spread a bit of hamburger meat on a slide. Mash it in stain. Find animal cells in it.

4. Where do you think they came from?

MORE ANIMAL CELLS

K

Examine some already prepared slides of animal cells. The cover slips are permanently fastened to the slides.

5. What structures did they have that you also saw in your cheek cells?

6. What differences did you notice in the various cells?

A. WHAT CELLS ARE

You have been looking at cells, and talking and writing about cells. But we haven't explained what cells are. Let's try.

A cell is a tiny lump of living material. Cells are found in the bodies of animals. Does that agree with your observations?

Ernest E. Just was a biologist who investigated cells. He studied the way the parts of the cell work together.

COURTESY HOWARD UNIVERSITY

Dr. Ernest E. Just

B. HOW CELLS ARE ALIKE

With the microscope you examined yourself, a frog, and a cow (the hamburger). You probably examined other animals also.

In all these animals you saw cells. If you examined a thousand animals you would see cells in all of them. All animals are made of cells.

All cells have certain things in common.

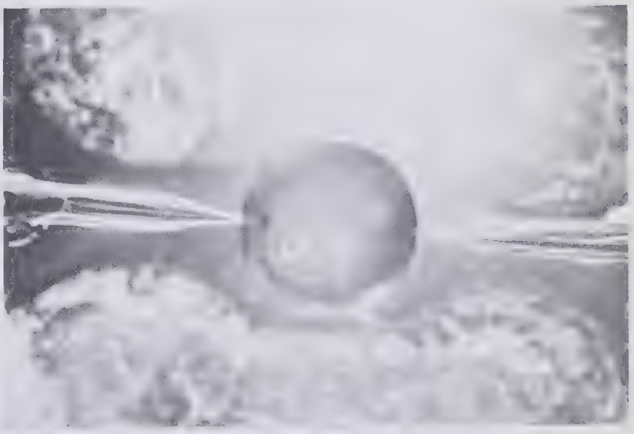
Every cell is surrounded by a cell membrane. The membrane holds the cell together. It also allows material to pass into and out of the cell.

Every cell also has a nucleus. The nucleus controls length of life and reproduction of the cell. It also controls inherited features.

I'm alive!
I'm a swinger!

Every cell has cytoplasm. Cytoplasm surrounds the nucleus. It does the everyday work of the cell. It digests and stores food. It contracts and causes cell movement.

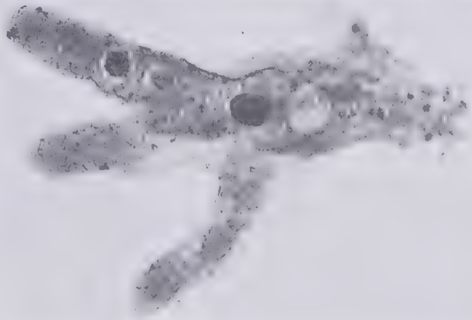
Operating on a single cell


JOHN GUTKNECHT, DUKE UNIVERSITY

C. YOU DON'T HAVE TO BELIEVE THE BOOK

We have just said that the nucleus of the cell controls reproduction. This isn't so just because the book says it is so. Experiments supply evidence for this claim. Under the microscope operations can be done on cells. Little glass needles like those pictured here are used in the operation.

Ameba


CAROLINA BIOLOGICAL SUPPLY CO

There is a little one-celled animal called **ameba.** Under the microscope a scientist can cut amebas in half.

One half of each ameba had the nucleus. The other half didn't. The scientist watched to see how many of the 2 different kinds of half-amebas lived. These were the results.

RESULTS OF AMEBA EXPERIMENT

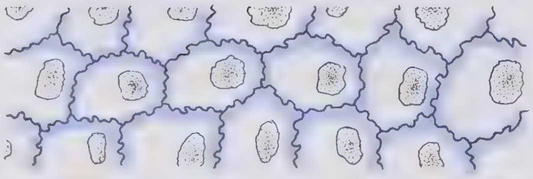
Day of Experiment	Number of Half-Amebas with Nucleus	Number of Half-Amebas without Nucleus
1	50	50
2	37	38
3	34	30
5	32	21
10	31	2
20	30	0
40	33	0
60	47	0

7. Describe the results.
8. What conclusion do you think the scientist made?

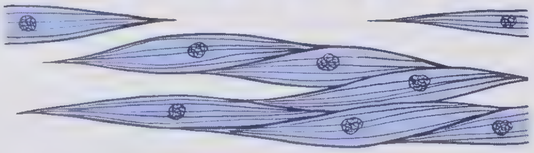
D. HOW CELLS DIFFER

Although all cells have the same basic parts, they differ in many ways.

Skin cells



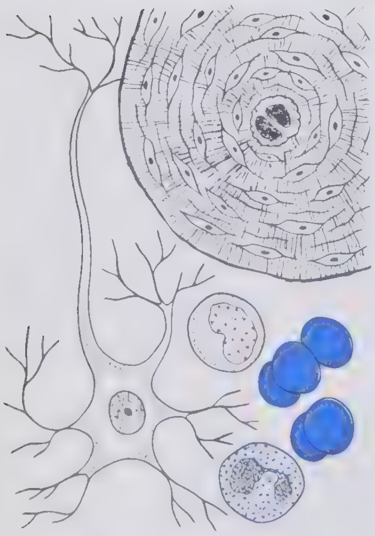
Muscle cells



Skin cells fit tightly together. Cheek cells fit tightly together also. These tight-fitting cells cover and protect parts of the body.

Muscle cells are long. They stretch and contract as they help you move. Some muscle cells have many nuclei.

Your body has other kinds of cells. These are bone, blood, and nerve cells. Each kind of cell is built to do its special job.



(top right) Bone with bone cells
(bottom) Blood cells
(left) Nerve cells

E. HOW BIG ARE CELLS?

Most cells are very small—smaller than you can imagine. It takes several hundred trillion of these tiny cells to make up your body.

But there are some cells that are quite large. Some eggs are actually very large cells. An ostrich egg is a cell big enough for you to sit on.

Nerve cells carry messages. They have to stretch from one part of the body to another. Some are one meter long.

You can see that cells vary in many ways. But, no matter how much they differ, they are all built on the same basic plan.

9. List the ways in which all cells are alike.

5

WHAT PLANTS ARE MADE OF

Plants are alive, just like animals. Plants are made of cells, just like animals.

In fact, the name "cell" was first applied to the tiny blocks that make up living plants.

word guide

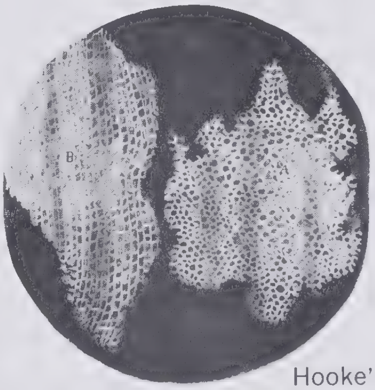
adrenal
ad-REE-nuhl
chlorophyll
KLAWR-uh-fil
chloroplast
KLAWR-uh-plast
cortisone
KAWR-tuh-sohn
elodea
el-oh-DEE-uh
hormone
HAWR-mohn
vacuole
VAK-yoo-ohl

A. EMPTY CELLS

Almost 400 years ago Robert Hooke, an English scientist, was working with a homemade microscope.

Hooke decided to look at a slice of cork.

Corks are made from the bark of Spanish oak trees.

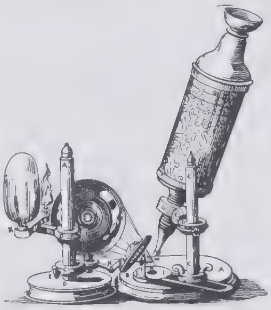


NATIONAL LIBRARY OF MEDICINE

Hooke's drawing of cork cells

With his microscope Hooke examined the cork. He saw rows of little empty blocks. They reminded him of the cell-like rooms that monks lived in. He gave the name "cell" to the empty blocks.

Of course the cork was dead. The living material was long gone from each of the cells. What Hooke saw was only cell walls.

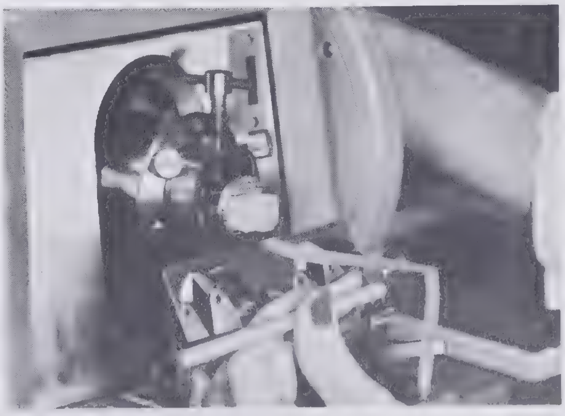


NEW YORK PUBLIC LIBRARY

Hooke's microscope

B. LIVING PLANT CELLS

Later Hooke and other scientists examined slices of living plant tissue. They saw the same rows of cells in the living plant tissues that Hooke had seen in the cork.



CAROLINA BIOLOGICAL SUPPLY CO.

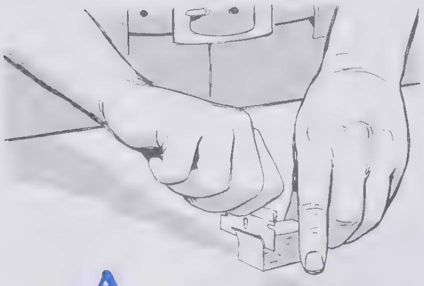
Slicing tissue

In each cell, the space within the walls was filled with living material. This living material is the important part of the cell. The living material is delicate. The cell wall protects it.

All plant cells have cell walls. This is one of the main ways they differ from animal cells. As you do the PLANT CELL ACTIVITY, look for other differences.

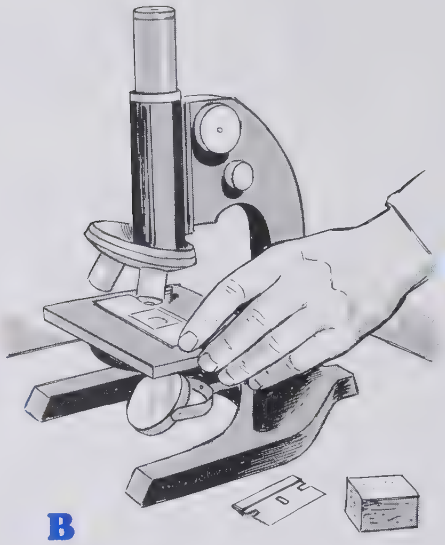
PLANT CELL ACTIVITY

CORK CELLS



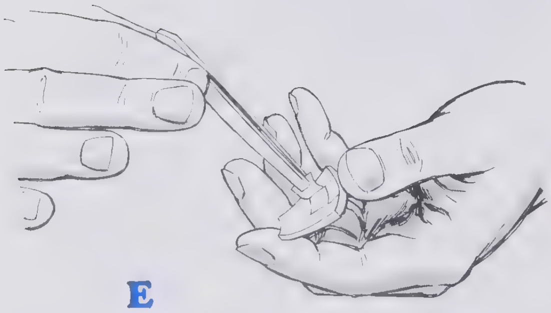
A

With a single-edged razor blade, carefully cut a thin slice of cork.



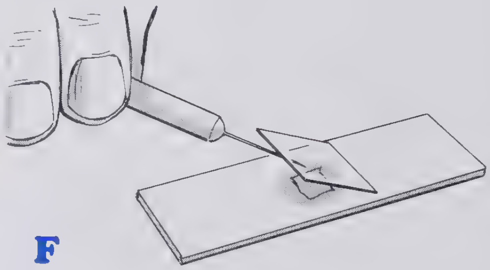
B

Make a slide. Examine thin edge of slice. Draw or describe what you see.



E

Remove one square of thin onion skin.



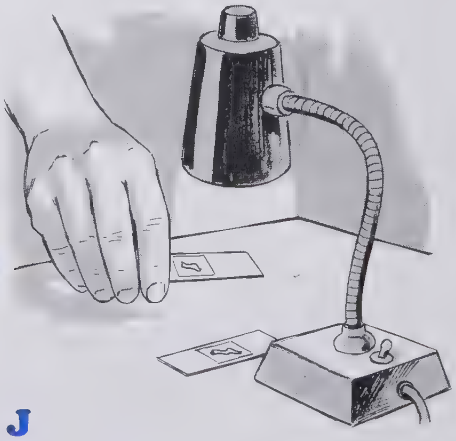
F

Mount it in stain. Examine it under the microscope.

ELODEA CELLS

I

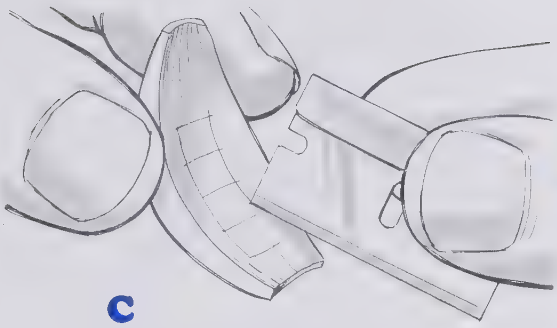
Elodea is a water plant. Pick a young leaf from the tip. Pick an older leaf from farther down.



J

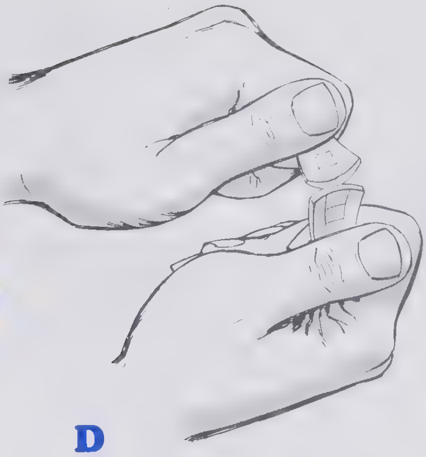
Mount both leaves in water on separate slides. Place the slide with the young leaf under a lamp for about 5 minutes. Watch to make sure it doesn't dry out.

ONION CELLS



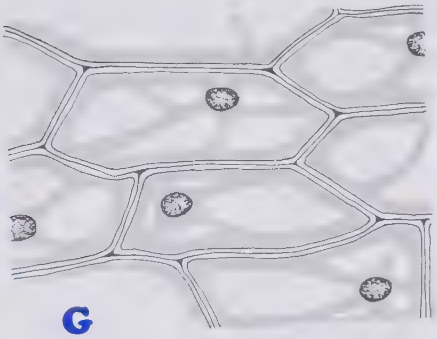
C

Take an inner leaf of an onion. With a razor blade, cut some 5 mm ($^1/_4$ inch) squares on the inner side of the leaf.



D

Snap the leaf backwards.

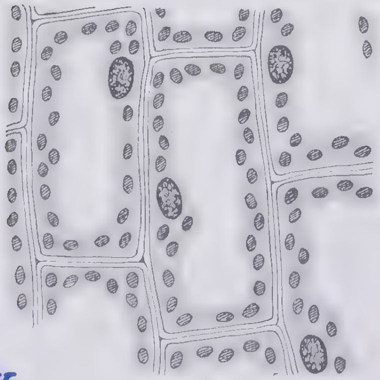


G

Can you see the nucleus?
Cytoplasm?
Cell membrane?
Cell wall?
Vacuole which appears as empty space?

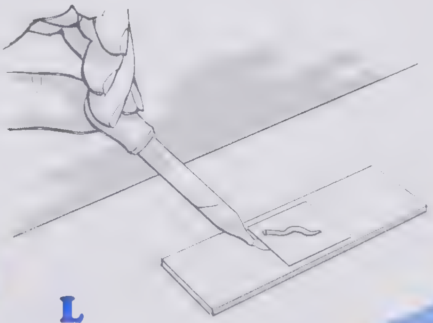
H

Turn to PLANT CELL WORKSHEET. In your notes name the parts of the onion cell that you saw.



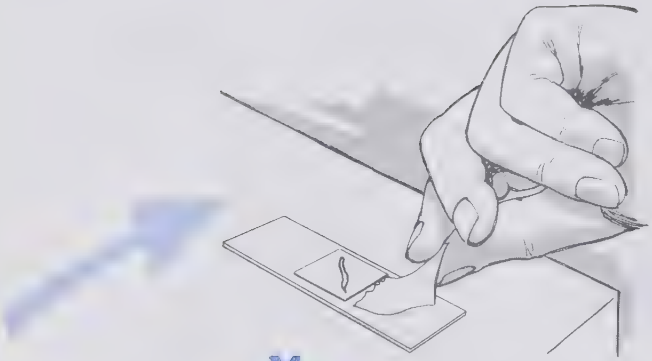
K

Examine the older leaf. What familiar parts do you see in the cells? The green bodies are **chloroplasts.** Again turn to PLANT CELL WORKSHEET. In your notes name the parts of the elodea cell that you saw.



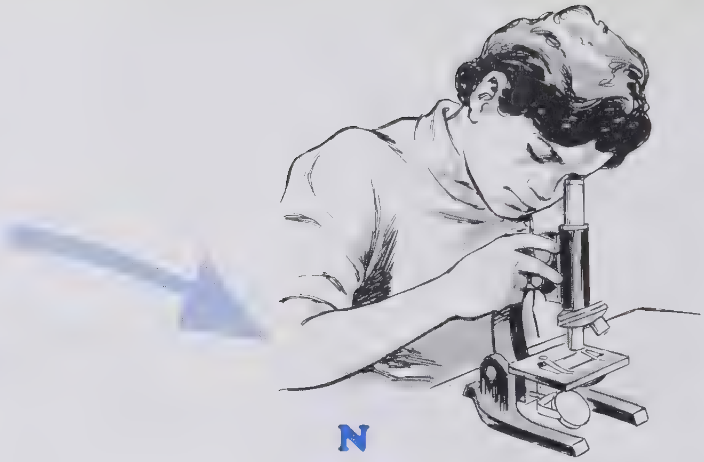
L

Add salt water at one edge of the cover slip.



M

Use paper towel to draw the salt water through.

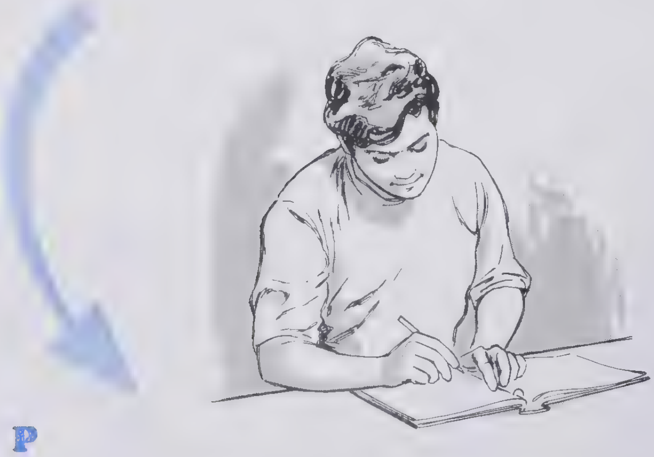


N

What has happened? You should now see the cell membrane clearly.

O

Examine the leaf that was under the lamp. What is happening?



P

Answer the questions.

1. What have you seen in the plant cells that you never saw in animal cells?
2. What differences were there between elodea and onion cells?
3. What did salt water do to the elodea cells? Can you explain this?
4. If the chloroplasts in elodea moved for you, how did they move? In what part of the cell? From one cell to another? All in the same direction?

C. SPECIAL PARTS OF PLANT CELLS

The chloroplasts contain an important green dye, **chlorophyll.** Plants use chlorophyll to make food for themselves. This is something no animal can do.

Large vacuoles filled with water are something else found only in plant cells. The water contains dissolved food. It helps keep the cells plump. When the cells lose their water, the plant wilts.

D. PLANT AND ANIMAL CELLS

So plant and animal cells differ. They are also very much alike. They have some of the same parts—nucleus, cytoplasm, and cell membrane. Their chemistries and the way they work are also similar.

For example, **cortisone** is an important **hormone** or chemical made by the **adrenal** gland in animals. Dr. Percy L. Julian found he could also get cortisone from soybeans and yams. Doctors use plant cortisone to help human patients.

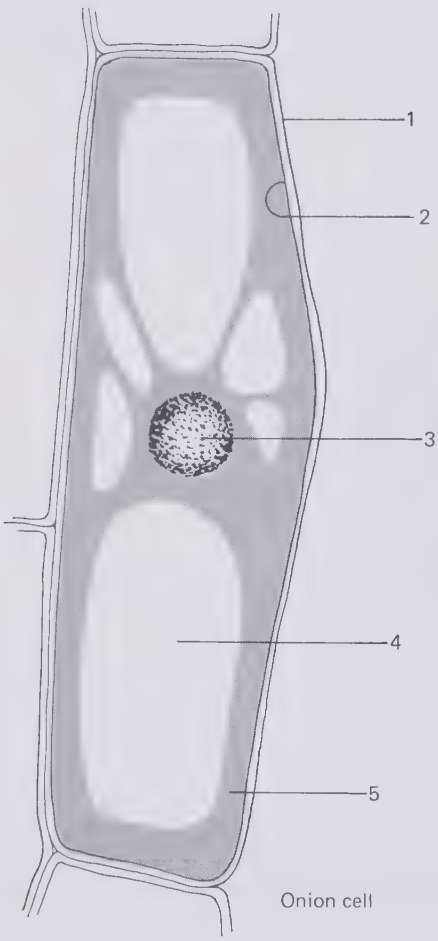
JULIAN RESEARCH INSTITUTE

Dr. Percy L. Julian

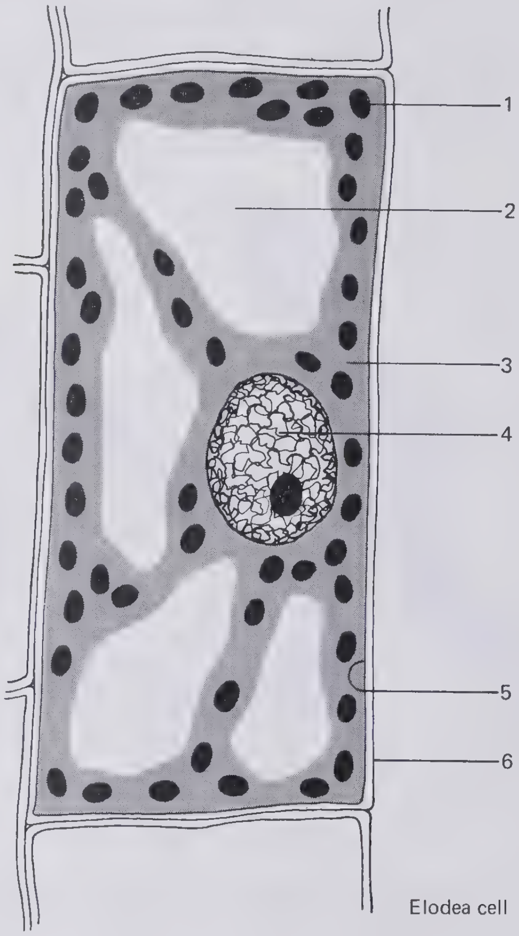
To help you summarize this chapter, copy and complete the TABLE OF CELL PARTS on the PLANT CELL WORKSHEET.

PLANT CELL WORKSHEET

In your notes name these parts of plant cells.



Onion cell



Elodea cell

TABLE OF CELL PARTS

	Check if Present in Cells of:				
Cell Part	Animal	Cork	Onion	Elodea	What Job Does the Part Do?
Nucleus					
Cytoplasm					
Cell membrane					
Large vacuole					
Chloroplast					
Cell wall					

6 SLIPPER HUNT

There are tiny, invisible animals everywhere in water. When conditions are right for them, they are very numerous. When the water is dirty, they die and become scarce.

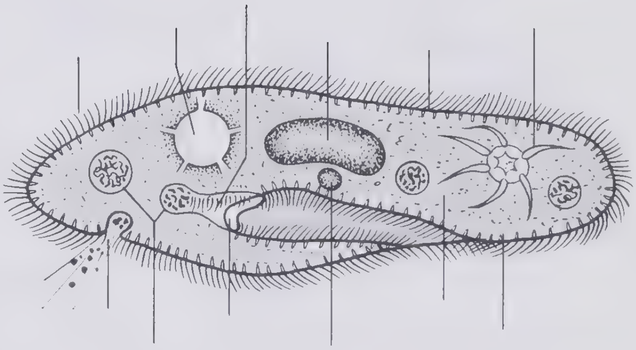
Some of these animals have only one cell. They are called **protozoa.** With its single cell, a protozoan does everything that you do in order to keep alive.

word guide

cilia	*SIL-ee-uh*
paramecium	*par-uh-MEE-see-uhm*
protozoa	*proh-tuh-ZOH-uh*

A. THE PROTOZOA

A one-celled animal moves. It eats. It breathes. It excretes wastes. It reproduces. It senses what is going on around it.



Structure of paramecium

You can watch some of these activities with your microscope.

Like other cells, a protozoan has a cell membrane, cytoplasm, and a nucleus or several nuclei. But because the animal has to do everything with its single cell, there are many other structures within the cell.

It is hard to see all these structures and activities in the living animal. It will help if you also look at pictures, and at stained permanent slides. Then you can figure out how protozoa are built and what they can do.

COURTESY AMERICAN OPTICAL CORP.

Paramecium magnified

B. PARAMECIUM—THE SLIPPER ANIMAL

Paramecium is one of the most common protozoa. However, making it hold still long enough to examine it is not easy.

1. From the pictures, can you tell why this protozoan is called "slipper animal?"

Paramecium is covered with little hairs called **cilia.** It swims with the cilia. It also spins, bends, and flops around.

Most of the time it swims front end first. But when it bumps into something, it can swim backwards.

Paramecium also eats with its cilia. It sweeps food into bubbles called vacuoles. The food is digested in these bubbles. Then the bubble bursts, and the wastes pass out.

C. FOR THIS YOU NEED SOME LUCK

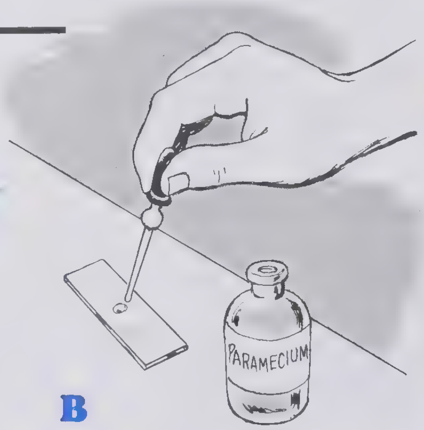
You may also see 2 special star-shaped vacuoles. They are called the contracting vacuoles. They fill with water. Then they squeeze the water out.

You may be lucky enough to see paramecium reproducing. When it reproduces, it pinches across the middle. Then it splits into 2 daughter cells.

PARAMECIUM ACTIVITY

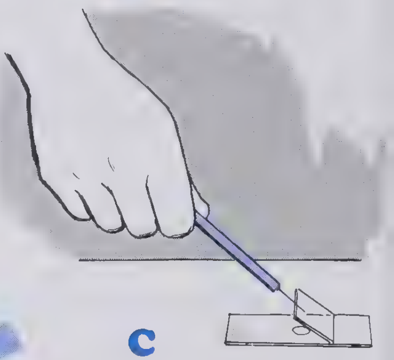
A

Place together on a slide a drop of methocel, a drop of Congo red, and a few threads. The methocel and the threads will slow down the protozoa.



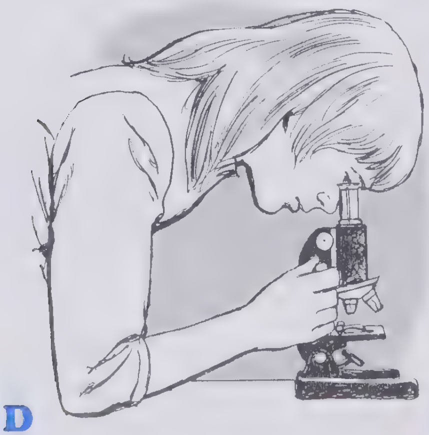
B

Add a drop of paramecium culture.



C

Add cover slip.

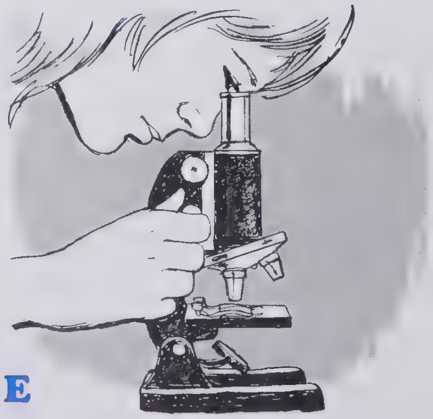


D

With low power, find a paramecium that has been trapped. Watch it swim and eat.

2. Is the "heel" or the "toe" the front end? How do you know?

3. Describe how the paramecium feeds.



E

When you are sure you have caught a paramecium, switch to high power. Watch the vacuoles and cilia working. What else can you see?

4. What other activities did you see the paramecium do?

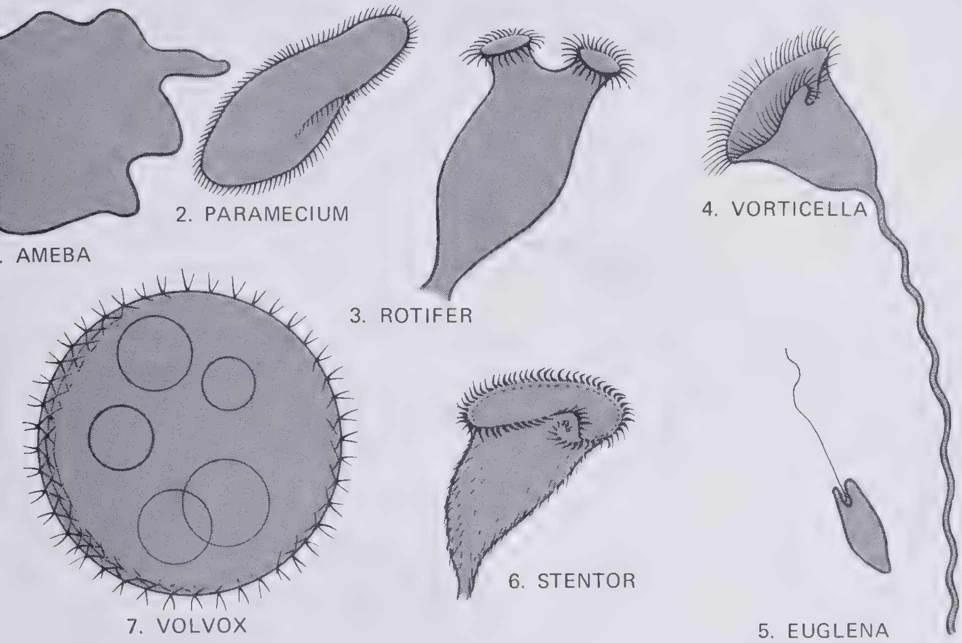
5. Copy the drawing of paramecium on page (25) 153. Label as many parts as you can.

7 THE LITTLEST ANIMALS

There are several thousand different kinds of one-celled animals called protozoa. If you are lucky, and a good microscope hunter, you can spot a number of them in a short time.

word guide

asexual	*ay-SEK-shoo-uhl*
diarrhea	*dy-uh-REE-uh*
dileptus	*dy-LEP-tuhs*
euglena	*yoo-GLEE-nuh*
flagellum	*fluh-JEL-uhm*
rotifers	*ROH-tuh-fuhrz*
stentor	*STEN-tawr*
volvox	*VOL-voks*
vorticella	*vawr-tuh-SEL-uh*

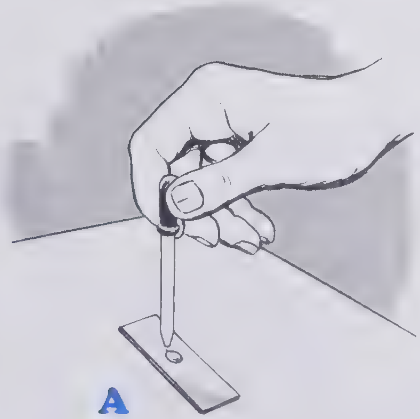


These microscopic animals are all one-celled except 3 and 7.

Protozoa differ in size. With the naked eye, you can just make out the biggest of them as little specks. The smallest, **euglena,** is only a fraction the size of an ameba.

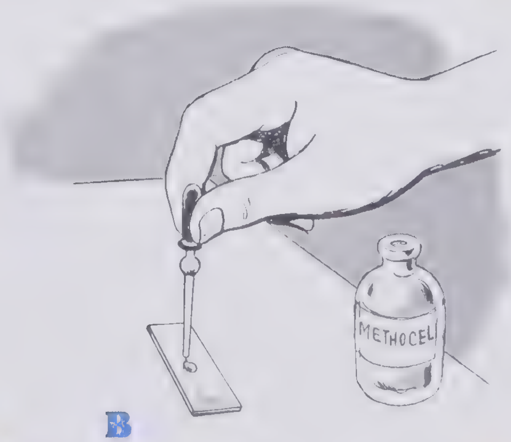
You may not see all the one-celled animals mentioned in the PROTOZOA ACTIVITY. Look at as many as you can find.

PROTOZOA ACTIVITY



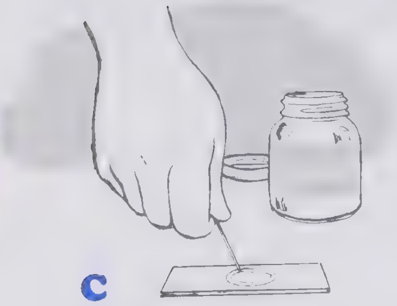
A

Make a slide of each protozoan you would like to study.



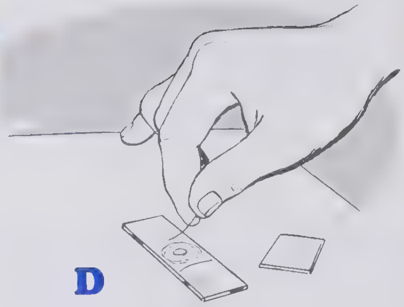
B

Use methocel to slow down the speedy ones.



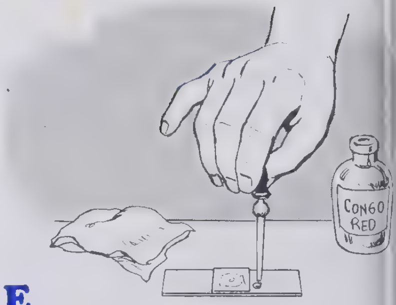
C

A vaseline ring will keep your slide from drying out.



D

Nylon bristles will hold up the cover glass and give the protozoa room to move.



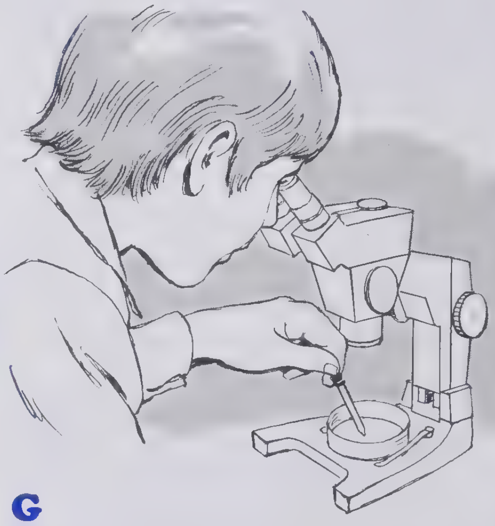
E

Feed protozoa with Congo red to see it eat and digest.

F

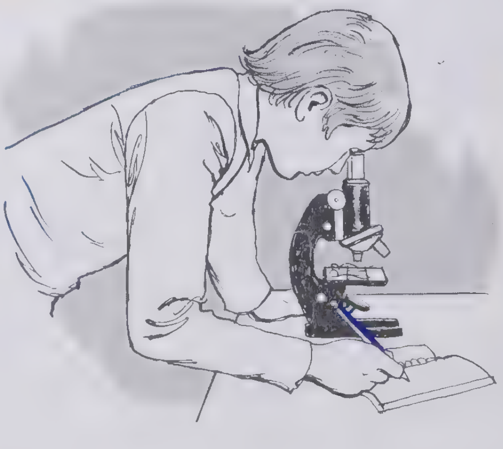
A prepared slide will show you things that you did not see in the living protozoa.

AMEBA



G

Hunt for an ameba on bottom of dish.



H

Draw your ameba. Wait 2 minutes. Then draw it again. Compare the drawings.

1. What did your ameba do as you watched it?

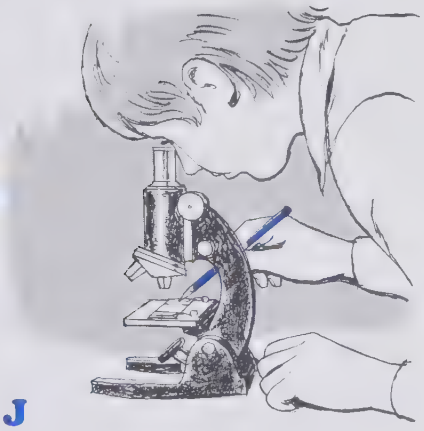
EUGLENA

I

Watch euglena respond to light.

2. How does euglena respond to light?

VORTICELLA, ROTIFERS

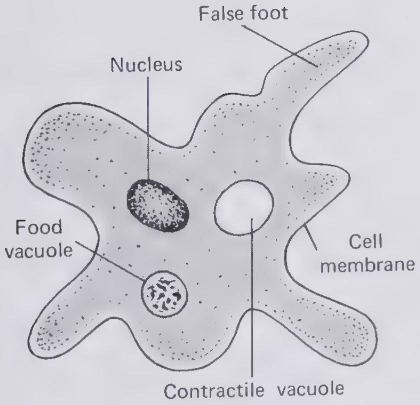


J

Gently tap the slide with a pencil.

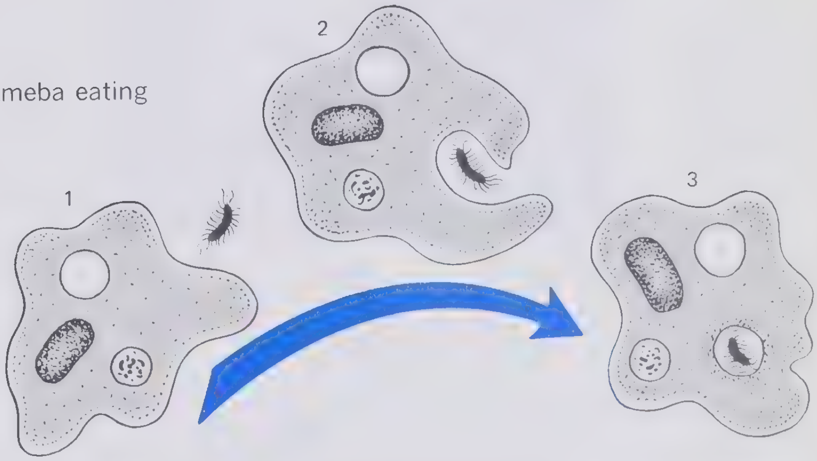
3. What do these animals do when you tap the slide?
4. How do **rotifers** feed?

A. AMEBA—THE BLOB



Ameba has no definite shape and no cilia. It moves by stretching out "false feet" and flowing into them.

Ameba eating



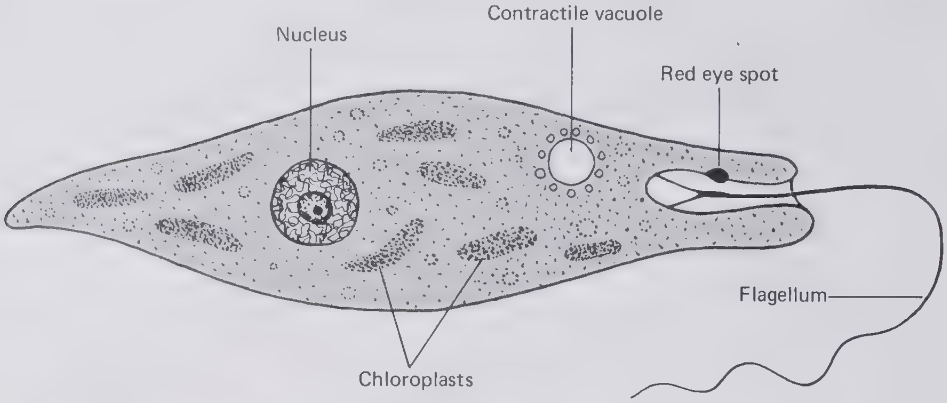
This shapelessness helps the ameba eat. The ameba flows around bacteria, smaller protozoa, or small plants. The ameba encloses the food in a vacuole, and digests it.

A large contracting vacuole regulates the amount of water in the ameba. When it contracts, water is pumped out through the cell membrane.

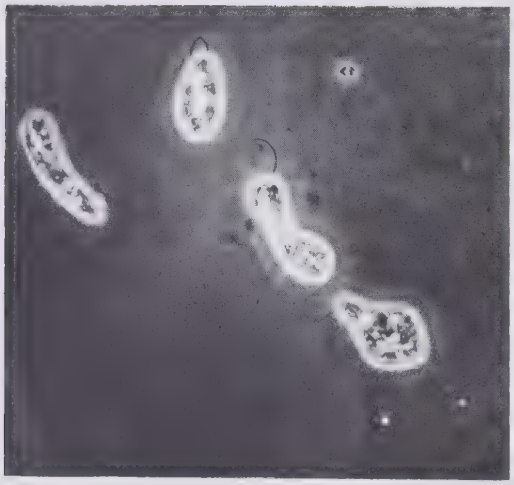
5. How does an ameba move?
6. How does an ameba eat?
7. What does the contracting vacuole do?
8. Copy and label the picture of ameba.

B. EUGLENA—THE PLANT-ANIMAL

Although euglena is small, it is many times bigger than microbes such as bacteria.



Euglenas


COURTESY AMERICAN OPTICAL CORP.

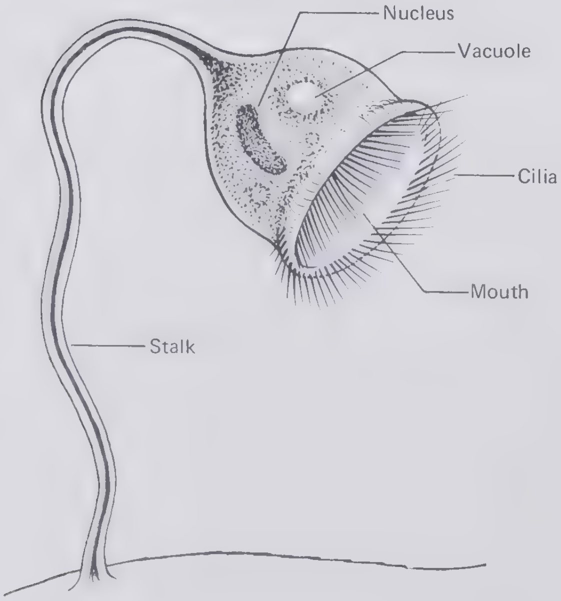
Euglena swims by beating a long whip called a **flagellum** that stretches out in front.

This protozoan is a colorful little fellow. It has green chloroplasts, just like a plant cell. With these chloroplasts it can make some of its own food.

It also has a red eyespot that helps it see.

9. Why is euglena called a plant-animal?
10. How does euglena move?
11. Copy and label the picture of euglena.

C. VORTICELLA—THE BELL ANIMAL

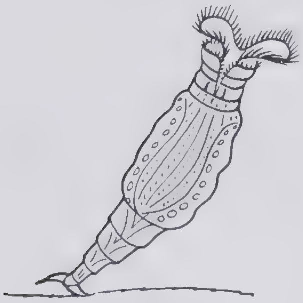


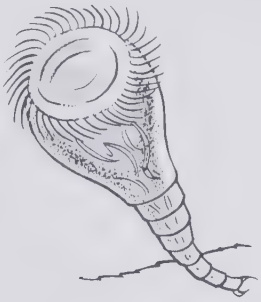
This pretty little animal grows on a stalk.

Cilia around the top of the "bell" help it feed.

The stalk can let go. Then the **vorticella** swims away and finds a new place to attach itself.

D. ROTIFERS—THE WHEEL ANIMALS





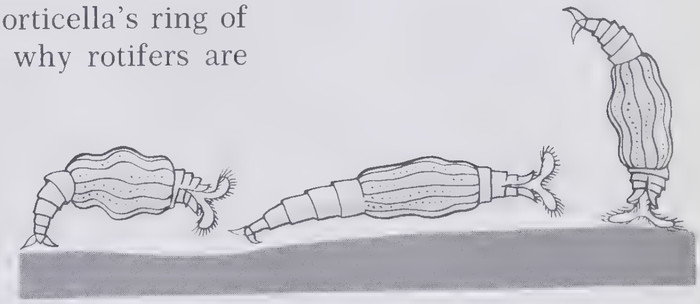
Rotifers are not protozoa. They are many-celled animals. Yet they are smaller than many protozoa.

Rotifers and protozoa are often found together.

A rotifer has 2 crowns of cilia, something like vorticella's ring of cilia. If you watch the cilia beating, you can see why rotifers are called "wheel animals."

Rotifers are usually attached to something solid. But they can let go and swim. They also walk and somersault in a comical way.

Rotifer walking

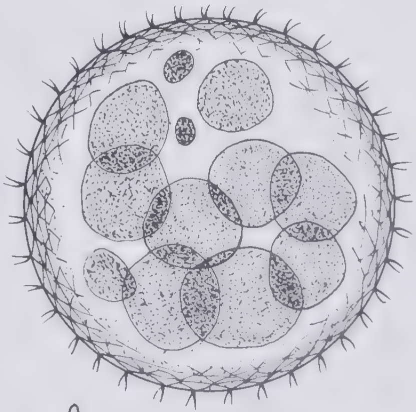


12. Describe how rotifers move.

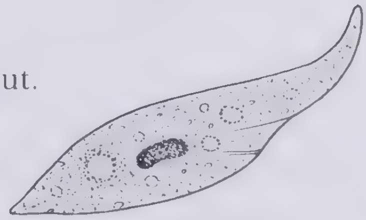
E. STILL MORE PROTOZOA

There are many other interesting protozoa that you may find. Here are a few of them.

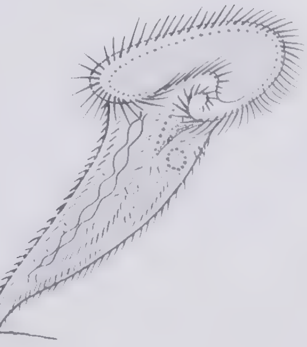
Volvox is a round, hollow, green ball of cells that goes spinning through the water. Each cell has 2 whips. Daughter cell-clusters are inside the large ball.



Dileptus has a long, wiggly snout.

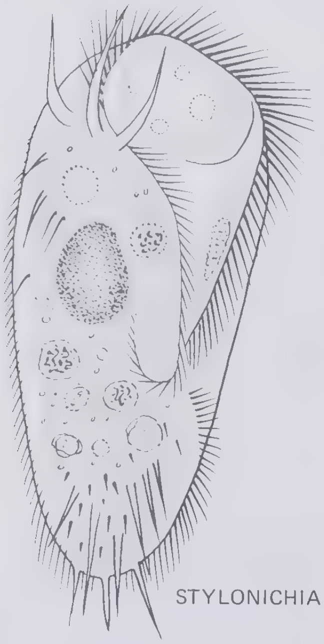


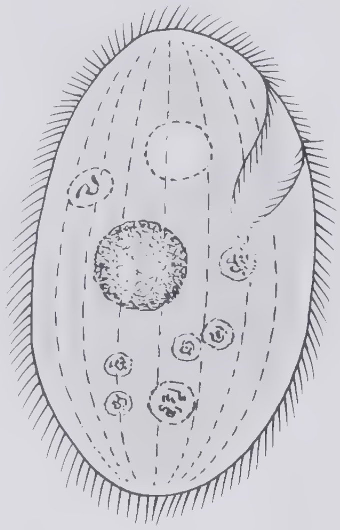
Stentor is the "trumpet animal." It has a crown of cilia like vorticella.

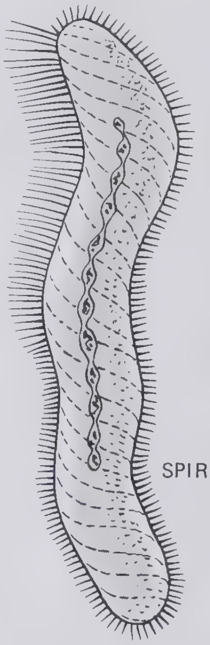


These 3 protozoa are fat and skinny relatives of paramecium.

13. How do they resemble paramecium?


STYLONICHIA

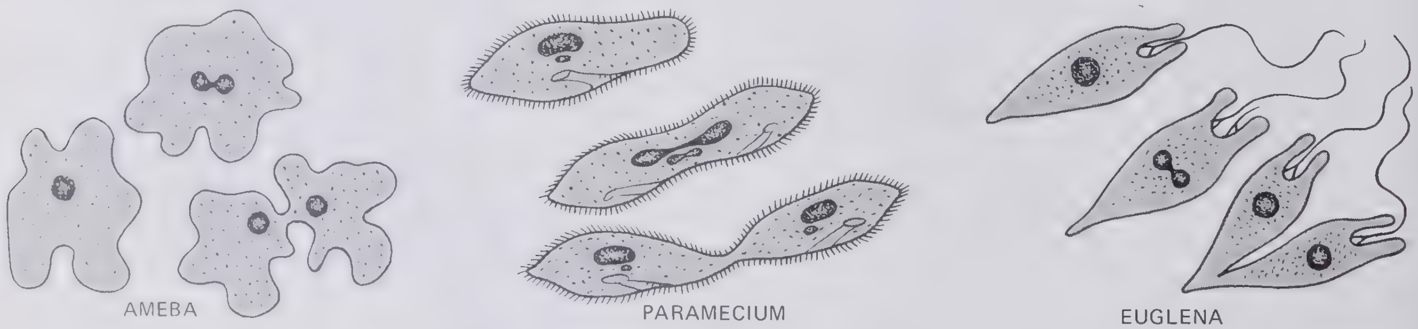

COLPIDIUM


SPIROSTOMUM

All the protozoa you have looked at are harmless. However, there are a few harmful ones. One causes sleeping sickness. Another causes malaria. A relative of ameba causes **diarrhea** or "the runs."

F. SPLIT

Every ameba has only one parent. This is true also of paramecium, euglena, and many other microscopic forms of life. When these cells reproduce, the parent cell splits in half.


Asexual reproduction by protozoa

AMEBA PARAMECIUM EUGLENA

This kind of reproduction is called **asexual.** Asexual reproduction involves only one parent. No sex is involved. An advantage of asexual reproduction is that the offspring are all identical.

14. Why is ameba said to be asexual?
15. When euglena reproduces, how many offspring can it have?
16. How would you compare the way euglena splits to the way ameba and paramecium split?
17. When asexual reproduction is over, what happens to the parent?
18. People have said that an ameba can almost live forever. How is this possible?

8 SOURDOUGH

Have you ever heard of sourdoughs? In Alaska, sourdough is the name for tough mining prospectors.

A sourdough hits the trail with a sack of flour and a starter of sour dough. With flour, water, and a bit of sour dough starter, he or she can bake fresh bread every morning. A sourdough will fight for sour dough starter.

word guide

fermentation
  fuhr-men-TAY-shuhn
yeast
  YEEST

Steal my gold and I'll fight, but take my sourdough starter, and you're in for real trouble!
XXXX FLOUR

A. GET YOUR OWN STARTER

Some of the early starters are still alive and in use in Alaska. A starter contains **yeast.** Yeast is a mass of one-celled plants. Yeast is used for baking and for making alcohol.

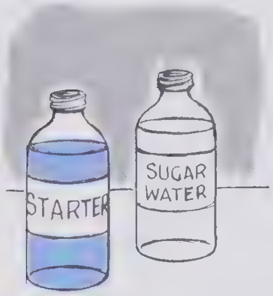
You will get a starter. This is a bottle of warm sugar-water and yeast. You will get another bottle of warm sugar-water without any yeast.

The yeast cells are warm and they have food. Would you believe that they are feeding, growing, and reproducing? Here is how you can see what is happening.

THE YEAST ACTIVITY involves watching 3 experiments at once. Plan carefully. You will be very busy.

YEAST ACTIVITY

FIRST EXPERIMENT



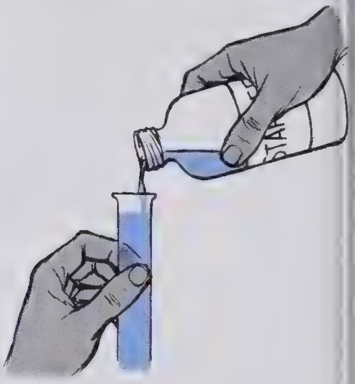
A

Get a bottle of sugar-water and yeast (starter) and a bottle of plain sugar-water.

B

Smell both bottles.

1. Which bottle smelled? Did the smell remind you of anything?



C

Fill test tube to overflowing with starter.

G

Watch both tubes during the period.

SECOND EXPERIMENT

H

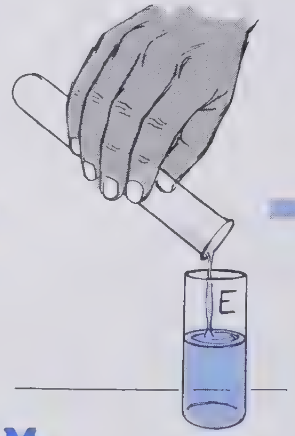
Make slide of starter mixture. Use a cover slip. Under the microscope find the yellow oval-shaped yeast cells.

BACK TO FIRST EXPERIMENT

L

Look at the test tubes.

4. What happened in the "E" test tube during the experiment? In the "C" tube?

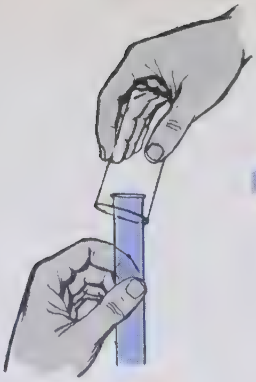


M

Lift the tube that contains gas.

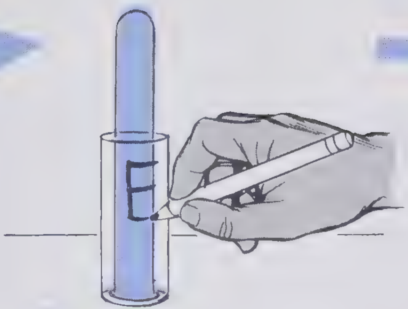
N

Cover with thumb and invert.



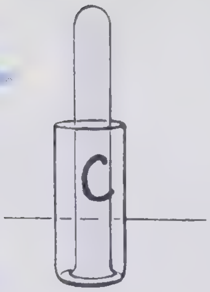
D

Cover with vial.



E

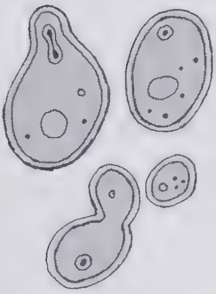
Turn upside down. Label "E" for EXPERIMENTAL.



F

Repeat steps C–E with plain sugar-water. But label the vial "C" for CONTROL.

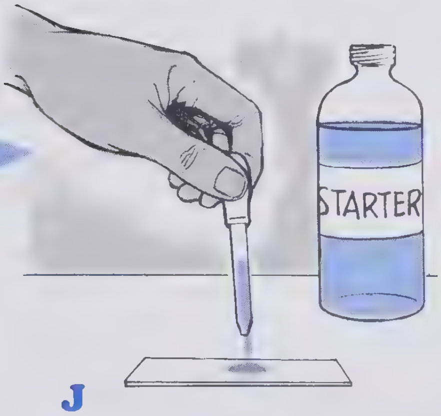
THIRD EXPERIMENT



I

Watch the bumps on yeast cells. These bumps are called buds.

2. What happens to the buds as you watch?



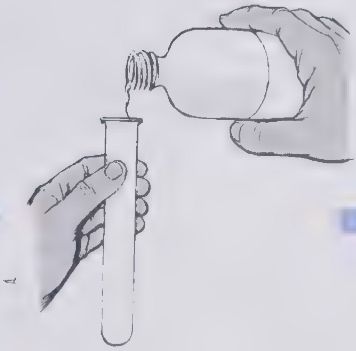
J

Place a drop of iodine stain on a clean slide. Add one drop of starter. Place cover slip on drop.

K

Find killed and stained yeast cells.

3. Make a large drawing of one stained yeast cell.



O

Quickly pour in 1 cm (½ inch) clear limewater. Shake.

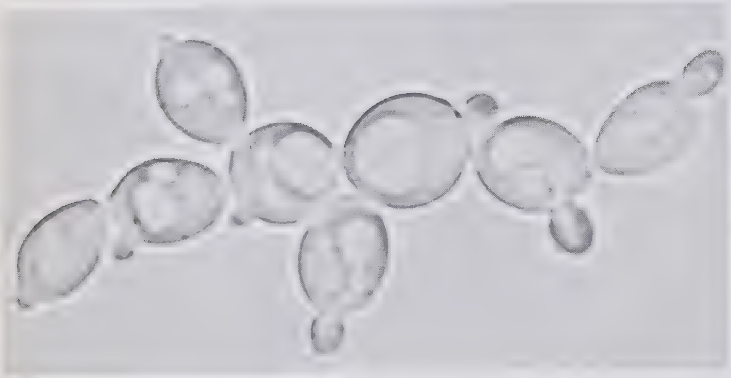
P

Cloudy limewater is test for carbon dioxide.

5. Which tube contains carbon dioxide gas? This tube also contains alcohol.

6. Where did the carbon dioxide and alcohol come from?

7. What does the CONTROL tube tell you?


FLEISCHMANN LABORATORIES.
STANDARD BRANDS, INC.

Budding yeast cells

B. BUDDING

Some of the cells you observed have tiny bumps or buds. Buds become new yeast plants. Only a single parent is involved in the reproduction of yeast cells.

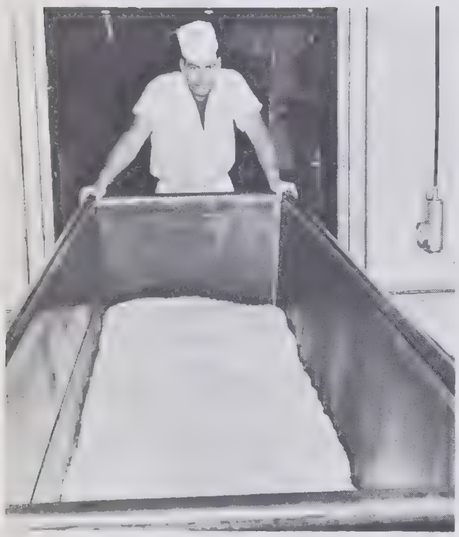
8. How do yeast cells reproduce?
9. What do we call this kind of reproduction?

C. FERMENTATION

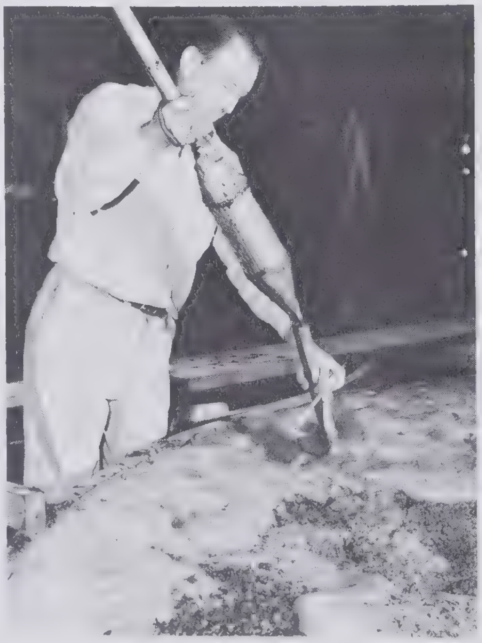
Yeast cells feed on sugar. They use sugar to make carbon dioxide and alcohol. This feeding process is called **fermentation.**

Yeast fermentation is a useful process. Carbon dioxide gas made by fermentation causes bread and cake to rise. The alcohol in beer, wine, and liquor is made by yeasts.

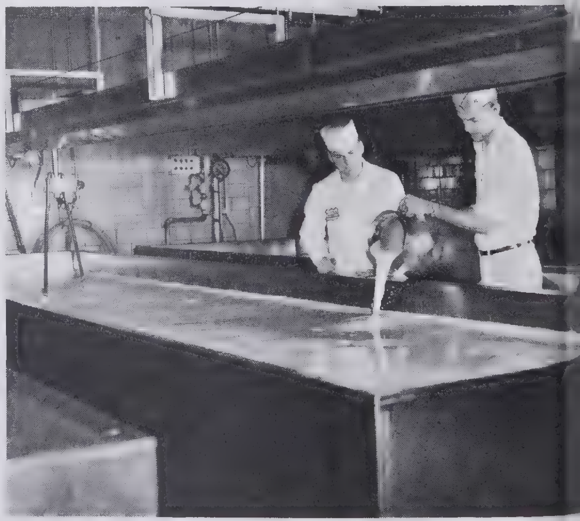
There are other kinds of fermentation. They produce buttermilk, vinegar, and many useful products.

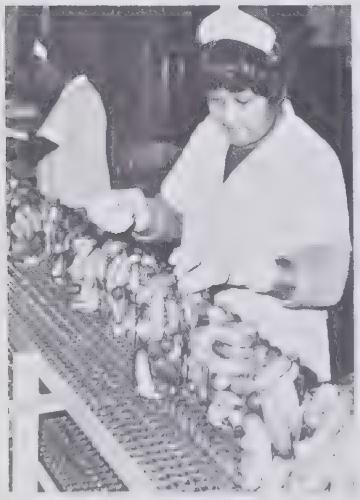

AMERICAN BAKERS ASSOC.

Dough


USDA PHOTO

Testing wine


Adding starter to make cheese


COURTESY R AND S PICKLE CO., INC.

Bacteria help make pickles

10. List the useful products of fermentation that you can find in the pictures.
11. List the jobs in fermentation industries that you can find in the pictures.

9

A MOLDY STORY

Several days ago you wet some bread. You put it in a container and left it in a warm place.

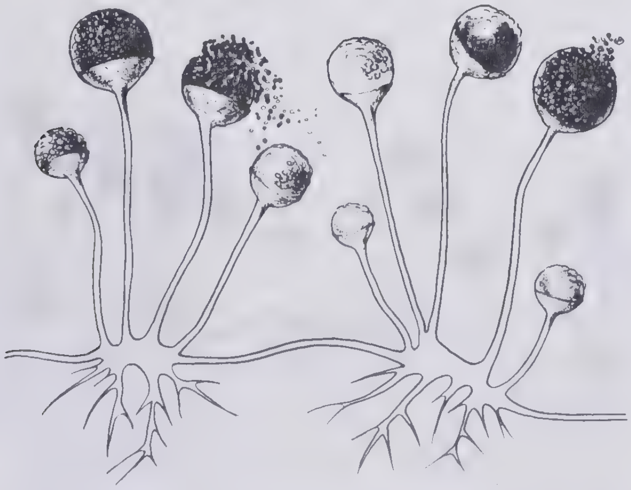
The bread has changed. It is covered with **mold.** You wouldn't eat the bread now. Mold spoils many kinds of food and clothing.

word guide

antibiotic
an-ti-by-OT-ik
mold
MOHLD
penicillin
pen-uh-SIL-in

A. MOLDS MUST LIVE TOO

Molds are living plants. They need food just as you do, and they use some of the same foods that you do. Molds form threads that grow all over the food. Food spoils as molds consume it.



As they feed, the mold plants reproduce. They form little round spores. The spores scatter. They blow all over. Many settle in dust. New mold plants may grow from them. You can see part of this reproductive process under the microscope.

GROWING MOLDS ACTIVITY

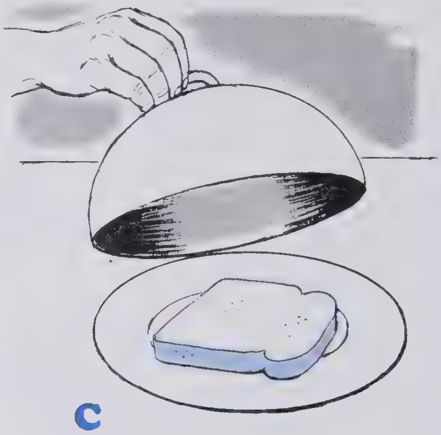
4 DAYS BEFORE THE ACTIVITY

A

Dampen a slice of bread.

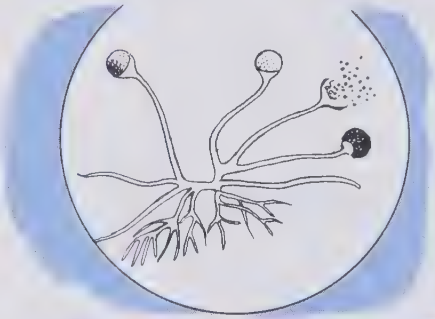
B

Rub it in dust.



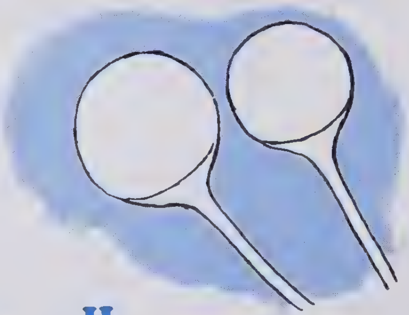
C

Put it in a covered dish. Keep it slightly damp.



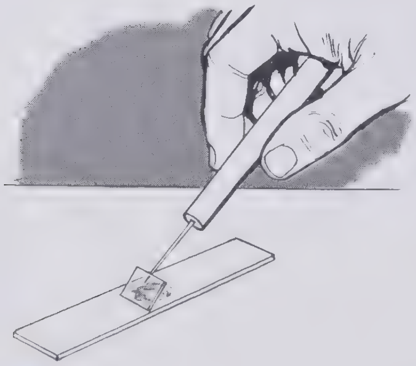
G

Find threads growing into the air. These are reproductive threads.



H

Locate round spore cases.



K

Make a slide of black bread mold in alcohol. Add a cover slip.

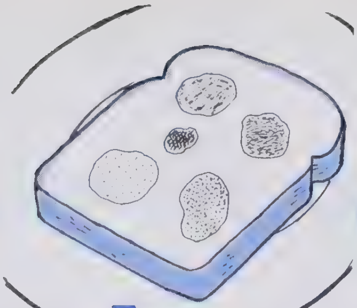
L

Examine with compound microscope.

THE DAY OF THE ACTIVITY

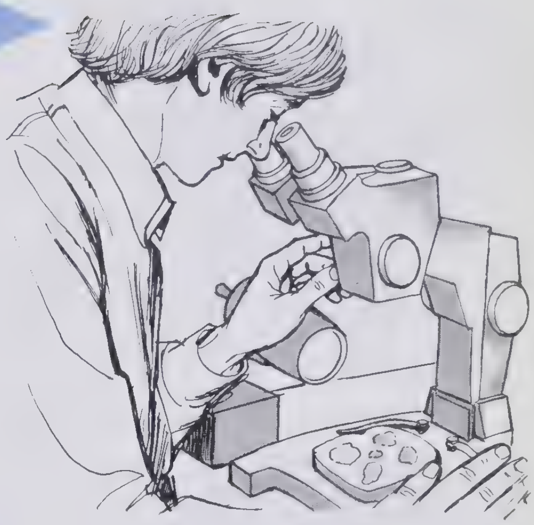
D

Smell the moldy bread.



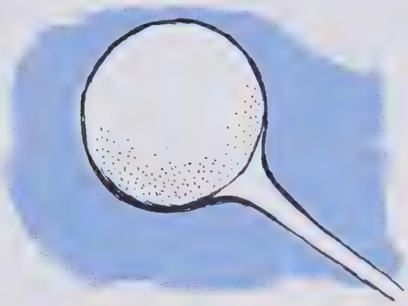
E

Look for several colors of mold. Each color is a different plant.



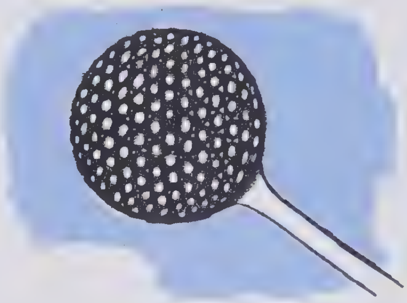
F

Find some black and white bread mold. Look at it with a dissecting microscope. Compare the picture.



I

Find white spore cases. These are not yet ripe.



J

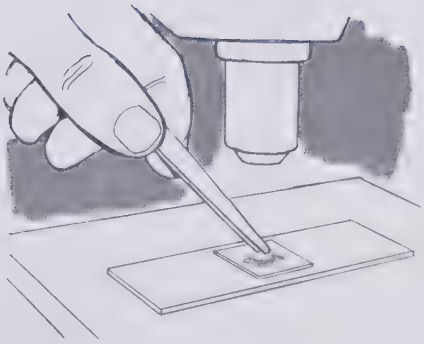
Find ripe, black spore cases. Each ripe case is full of spores.

1. Draw a ripe spore case.

M

Press cover slip gently and watch what happens to spores.

2. Draw 2 spores.
3. If they weren't under a microscope, where would the spores go?
4. Why did you rub your bread in the dust to start a mold growth?
5. How will your experiment help next year's class grow bread mold?
6. How do mold plants reproduce?



Dr. Fleming at work

B. SOME MOLDS ARE USEFUL

Molds make some foods taste better. Many good cheeses are moldy.

A Scotsman named Alexander Fleming studied a greenish mold that often grows on bread and oranges. Fleming found that the mold produces **penicillin.** This is an **antibiotic** that fights germs.

Molds have been grown that produce many other useful antibiotics. Louis T. Wright was a famous surgeon. He first used several of the new antibiotics to help patients recover from operations.

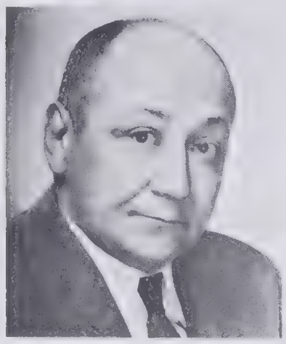
These molds make penicillin.

COURTESY CHARLES PFIZER AND CO., INC.

C. MOLD ENEMY NUMBER ONE

Food that is kept in a refrigerator doesn't usually get moldy. That is because the cold keeps the spores from growing, and slows down their reproduction.

Every family needs a refrigerator. It helps keep food from molding and spoiling.



NAACP

D. REFRIGERATOR FOR SALE

A refrigerator is a big item for a family to buy. It costs from $200 to $600. Most refrigerators are sold on time. This is called installment buying or credit buying.

Stores charge interest for giving credit. How much does the interest cost? The BUYING ON CREDIT WORKSHEET will help you figure this out.

Dr. Wright

Buying on Credit Worksheet

SAMPLE EXERCISE: What is the cost of credit on the $200 refrigerator if you take 12 months to pay?

Cash Price of Refrigerator if Bought Outright	Monthly Payments on Same Refrigerator Bought on Credit	
	12 Months to Pay	24 Months to Pay
$200	$18.17	$ 9.82
350	31.79	17.21

Monthly payment	$ 18.17
Multiply by number of months	× 12
Total of payments	218.04
Subtract cash price	−200.00
Cost of credit	18.04

1. What does "buying on credit" mean?
2. How much more does the $200 refrigerator cost if you take 24 months to pay?
3. What is the cost of credit on the $350 refrigerator if you take 24 months to pay?
4. Is it fair for the store to charge you for credit? Explain.

10 BEAN SOUP

Germs are all around you. The most common kinds of germs are bacteria.

word guide

bacterium	*bak-TIR-ee-uhm*
sterile	*STER-uhl*
sterilize	*STER-uh-lyz*

Bacteria cover your hands, body, and clothing. They are on the desk, on the floor, on everything you touch. They float on dust in the air. They live in water and in the ground.

A. IS IT BEAN SOUP OR BACTERIA SOUP?

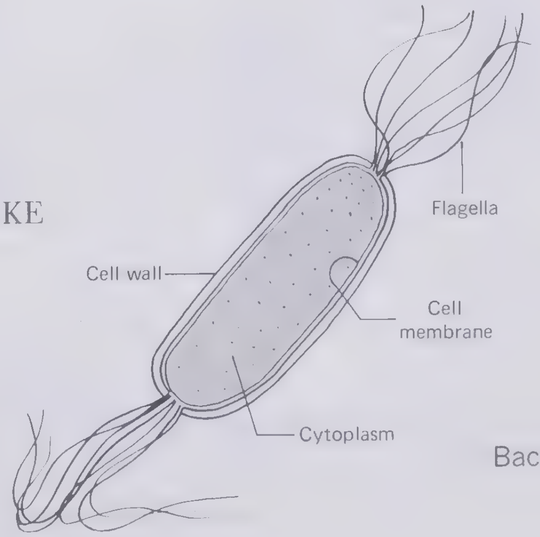
Bacteria are found on or inside many foods. Decaying food is always full of them.

A jar of beans and water left standing for a day is a great place for bacteria to grow. Every drop of this bean soup will contain thousands or millions of bacteria.

You can easily see, smell, and study these little germs.

B. WHAT BACTERIA LOOK LIKE

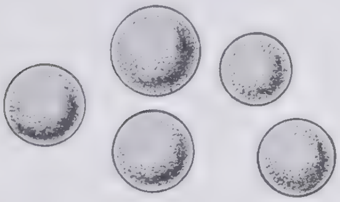
Each **bacterium** is a single, very simple cell. It has a cell wall, cell membrane, and cytoplasm. Some bacteria swim by means of tiny hairs called flagella. You can not see a distinct nucleus.



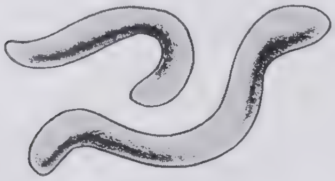
Bacteria cell

There are about 2,000 different kinds of bacteria, but they come in only 3 shapes.

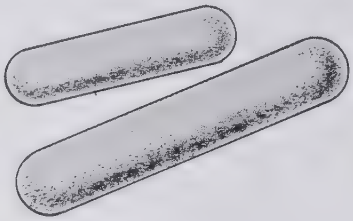
Some are round.

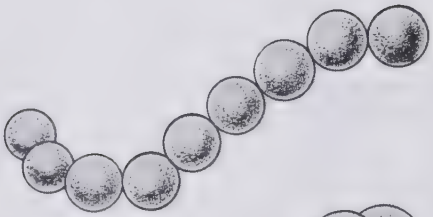


Some are curly.

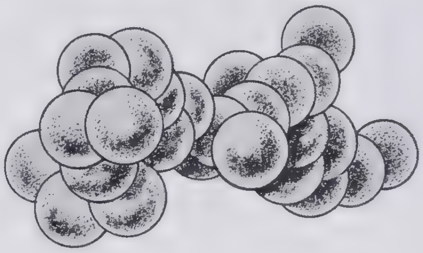


Some are rod-shaped.





Of course bacteria whose cells look alike may differ in other ways. Some may grow in chains.



Others may grow in clusters.

C. CAN THEY HARM US?

Most bacteria are harmless little things. In fact they help other forms of life by eating up wastes and garbage.

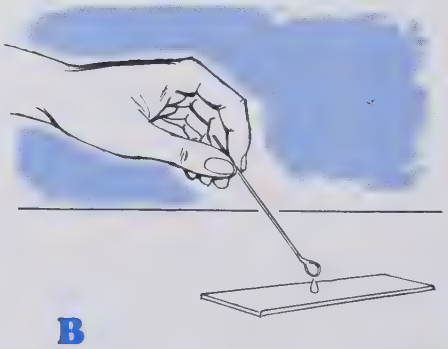
A small number of bacteria are harmful or cause disease. The bean soup may contain a few of these harmful forms. So you have to be careful in handling the soup.

Sterilize anything that comes in contact with the bacteria-loaded soup. That is, kill all the germs on the object. An object on which there is nothing living is said to be **sterile.**

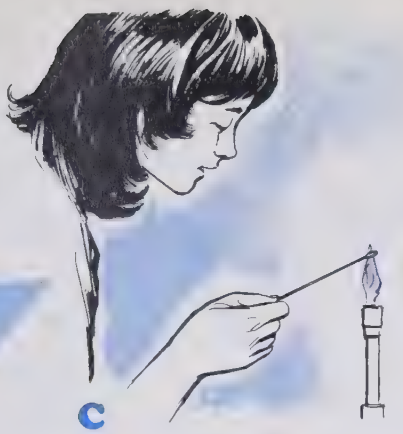
BEAN SOUP ACTIVITY

Get some cloudy bean soup. Look at it. Smell it.

1. How did the soup look? How did it smell?

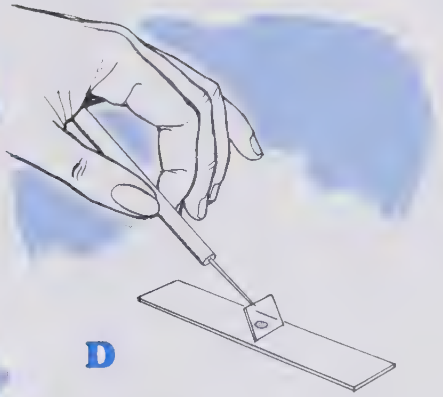


With a wire loop, put 2 or 3 drops of soup on a clean slide.



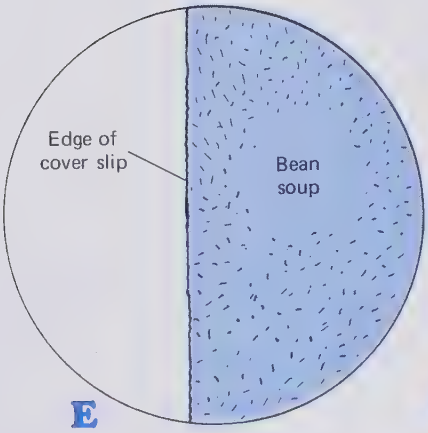
C

Heat the loop until it is red hot.
2. Why did you flame the loop?



D

Add a cover slip.



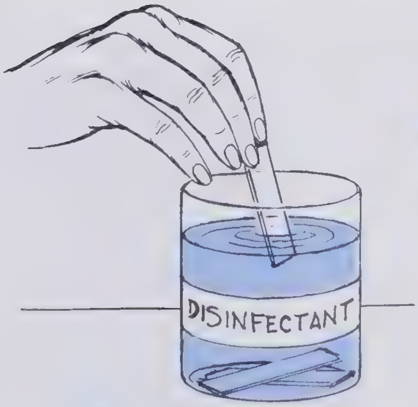
E

Put the slide under the microscope. With low power, focus on the edge of the cover slip.

F

Switch to high power. Brighten the light. Note the kinds of bacteria you see.

3. Can bacteria move? How do they move?



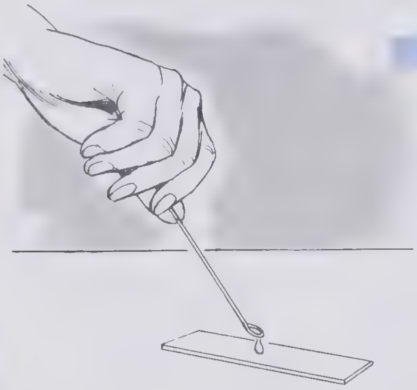
G

Place used slide in a jar of disinfectant.

4. What are 2 ways of killing bacteria?

H

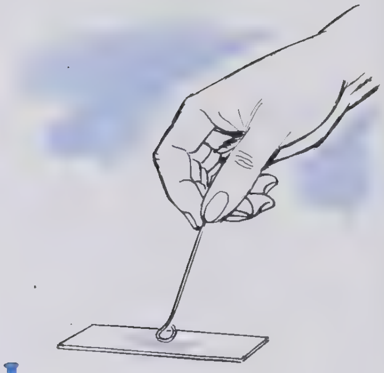
Get some clear soup. Look at it. Smell it.



I

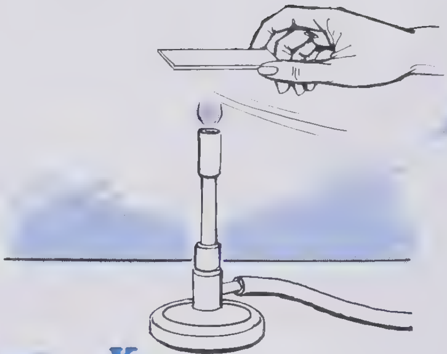
Put a drop of clear soup on a slide. Add a cover slip. Examine the soup.

5. Tell 3 ways that show when soup contains or doesn't contain bacteria.



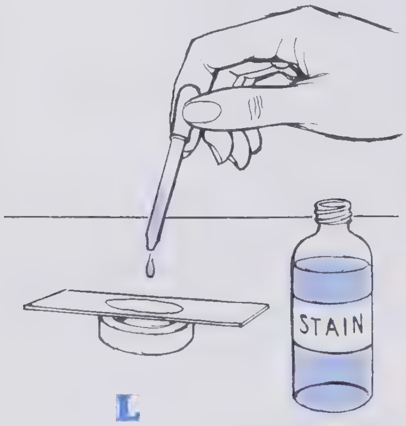
J

Using a wire loop, spread a thin layer of cloudy bean soup on a clean slide.



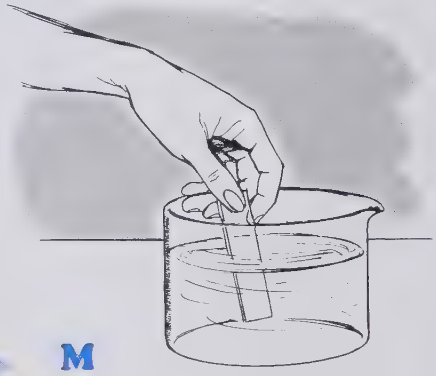
K

Let the slide dry. Then flame it.



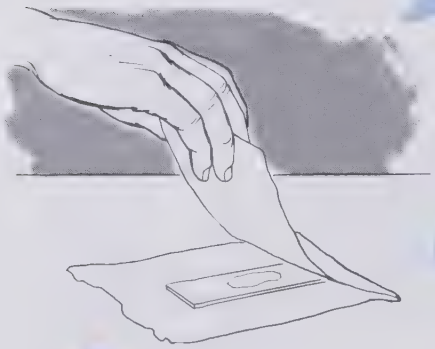
L

Put a drop or 2 of stain on the smear. Leave the stain on for 30 seconds.



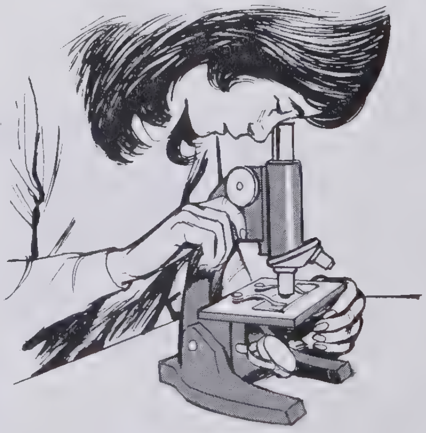
M

Rinse the slide in water to wash off the stain.



N

Blot the slide dry. Don't rub it.



O

Examine the smear without a cover slip.

6. What kinds of bacteria did you find in the soup?

11 THE GOOD GUYS

What good are bacteria?

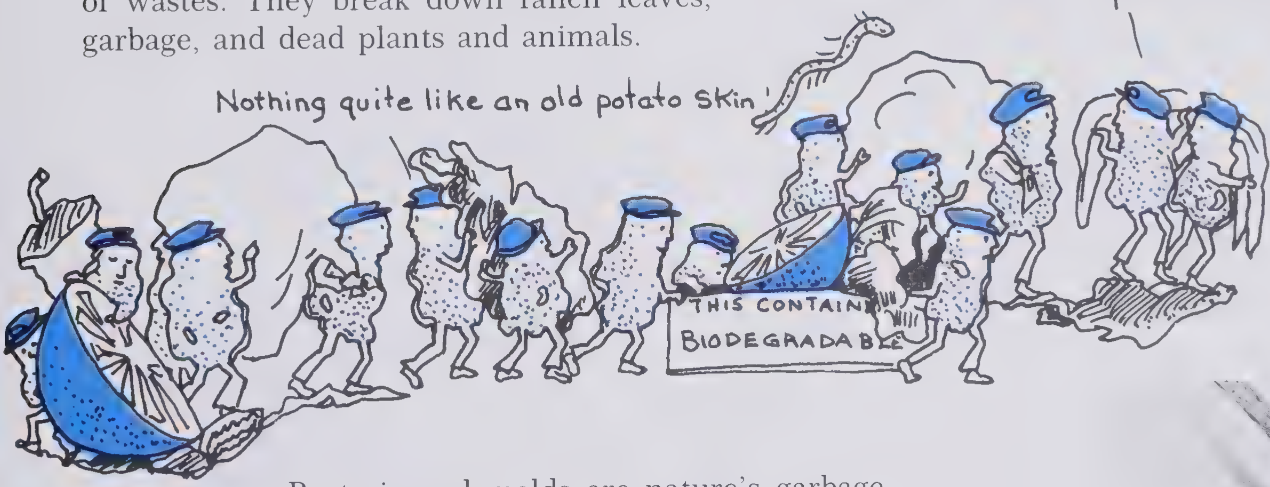
They help people in many ways. Let's look at some of the useful things they do.

word guide

nitrogen	*NY-truh-juhn*
sauerkraut	*SOWR-krowt*
utensil	*yoo-TEN-suhl*

A. THE GARBAGE COLLECTORS

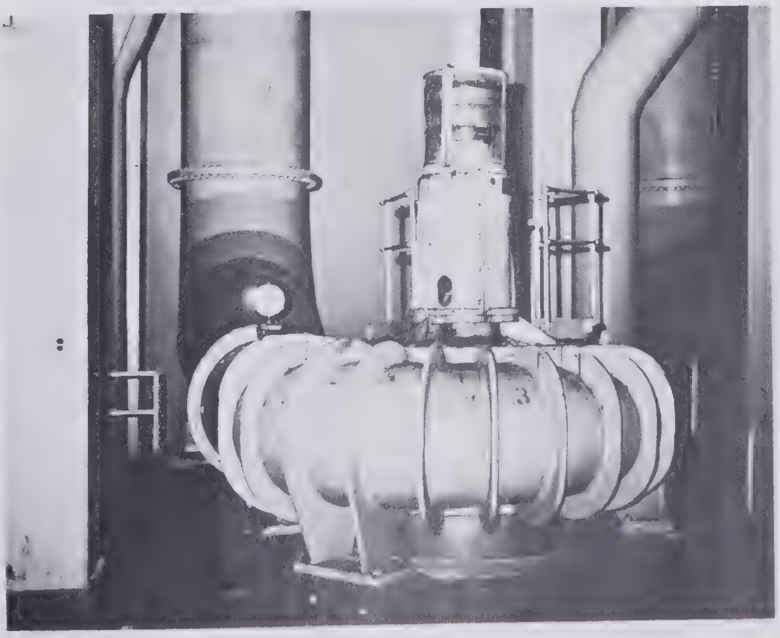
Bacteria consume and break down all kinds of wastes. They break down fallen leaves, garbage, and dead plants and animals.


Nothing quite like an old potato skin!
We like banana peels!
THIS CONTAIN
BIODEGRADABLE

Bacteria and molds are nature's garbage disposal system. Without them the world would soon be cluttered with wastes.

Maybe you have smelled a sewage disposal plant. The smell can be mighty strong. The odor means that bacteria are working on the sewage. Pretty soon they clean it up.

Decaying leaf with mold



COURTESY DEER ISLAND SEWAGE TREATMENT

Main pump in a sewage disposal plant

B. THE FOOD MAKERS

Swiss cheese

There are other kinds of bacteria. Some help give butter its flavor. Other bacteria make gases which put holes in Swiss cheese.

Some bacteria turn milk into yogurt. Others turn cabbage into **sauerkraut.** These processes are examples of fermentation. In the GOOD GUYS ACTIVITY you can make yogurt and sauerkraut. You will be able to see the bacteria that do these jobs.

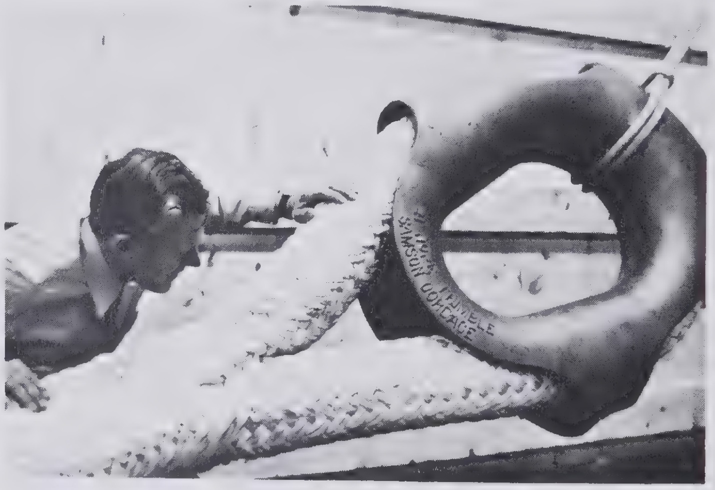
There are even helpful bacteria living in your intestines. They make some of the B vitamins that your body uses. When you are sick, the doctor may give you an antibiotic. The antibiotic sometimes kills the helpful bacteria. This may cause cramps. When the helpful bacteria grow back, you feel better.

C. LOVE THAT BUG!

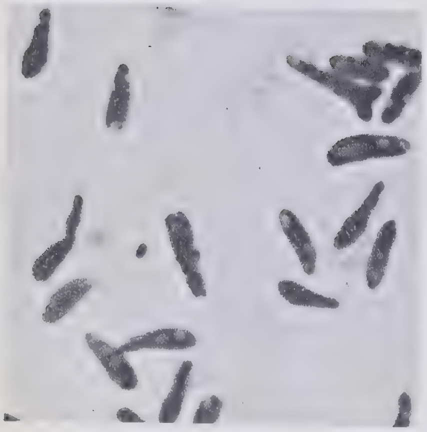
We could snow you with examples of useful bacteria, but we won't. Here are just a few more.

Fermentation by bacteria makes nail polish remover. Bacteria soften leather, cloth, and rope.

Fermentation loosens rope fibers from jute plants.

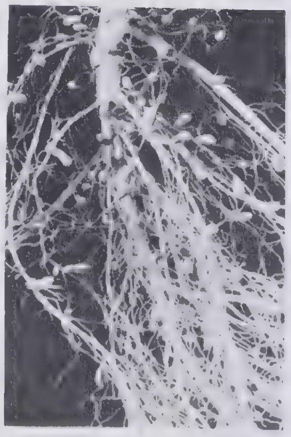


COURTESY SAMSON CORDAGE WORKS



USDA PHOTOS

Nitrogen-trapping bacteria



Finally, plants depend on bacteria. Special bacteria live in lumps on the roots of peas, beans, and clover plants. These bacteria trap **nitrogen** gas from the air by a chemical process and put it in the soil where other plants can use it.

Bacteria-rich lumps on clover root

1. Discuss this with your group. Are bacteria on our side, or aren't they?

GOOD GUYS ACTIVITY

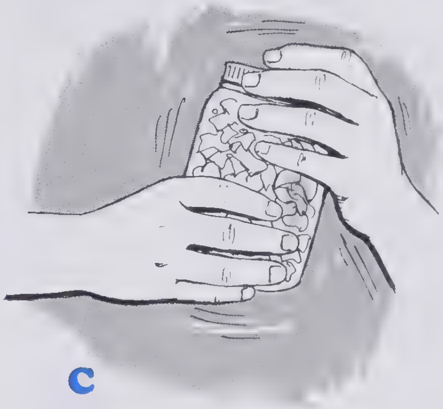
SAUERKRAUT ACTIVITY—3 DAYS AHEAD

A

Cut some cabbage into thin shreds. Stuff a clean jar with the cabbage.

B

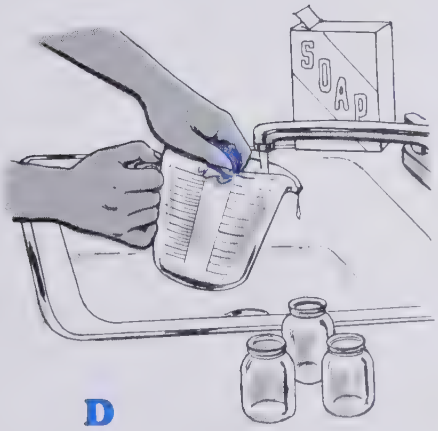
Add some sauerkraut juice. Then fill the jar with clean water.



C

Cover loosely. Shake out air bubbles. Leave jar in the warm room.

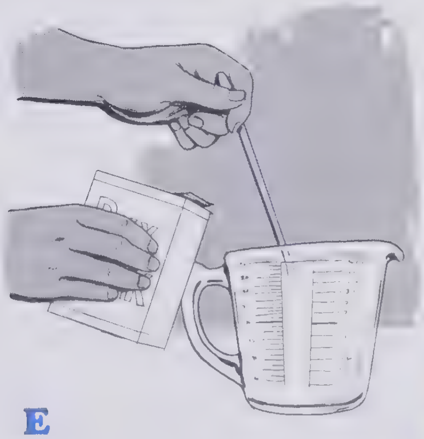
YOGURT PREPARATION—ONE DAY AHEAD



D

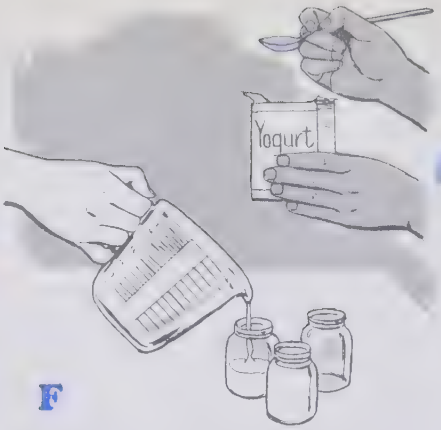
Wash **utensils** well.

2. Why do you need clean utensils?



E

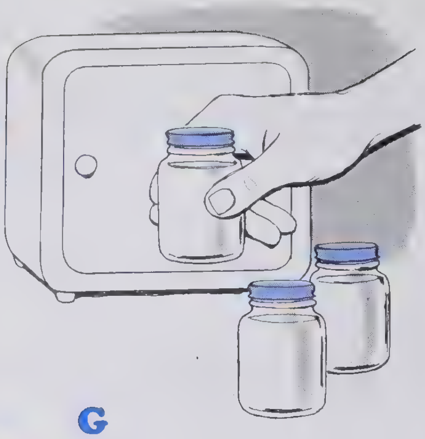
Mix dry milk in a liter (quart) of warm water. Use twice as much milk powder as the directions say.



F

Fill small jar with the milk you have made. Add one teaspoonful of yogurt starter. Stir well.

3. What is in the yogurt starter?



G

Cover loosely. Leave in warm place.

DAY OF THE ACTIVITY

H

Smell the sauerkraut.

4. What was the starter for the sauerkraut?

5. How did the sauerkraut turn out?

I

Smell your yogurt. Compare it to store yogurt.

6. How did your yogurt turn out?

J

Examine a drop of sauerkraut juice with the microscope. Make a dry smear, stain it, and examine it.

K

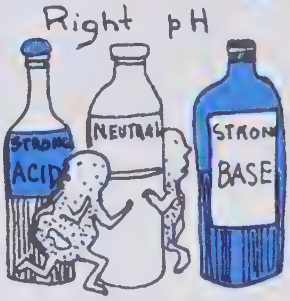
Repeat J for the yogurt.

12 THE BAD GUYS

word guide
methylene
METH-uh-leen
pasteurized
PAS-tuhr-yzd

Has milk ever spoiled and turned sour on you?

The milk spoiled because certain harmful bacteria grew in it. They fed on the milk and turned it sour. You had to throw it away.



A. CUT THEM OFF AT THE PASS

The bacteria grew because conditions in the milk were just right for them. Here are some of the conditions that bacteria need.

How do you stop the harmful bacteria? It's very simple. Just take away the good conditions they need.

CONDITIONS FOR CONTROLLING BACTERIA

Conditions That Bacteria Need	How to Remove the Conditions
Food	Cleanliness removes food from bacteria.
Water	Drying, as with dried peas and beans, removes water.
Warmth	Freezing makes bacteria too cold. Boiling makes them too hot.
Right pH	Vinegar and sauerkraut juice are too acid for bacteria.
Right amount of salt	Salt fish is too salty for bacteria.
Darkness	Let sunlight into the room. Use ultraviolet.

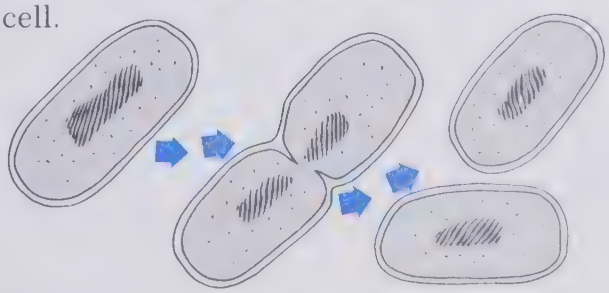
B. THE GERM EXPLOSION

When conditions are right, bacteria grow and reproduce.

They reproduce by dividing in half. Each half then grows to be a new bacterial cell. Bacteria can do this every 20 minutes.

At this rate, at the end of one day the bacteria would weigh 2,000 tons. Several days later the mass of bacteria would be bigger than the earth.

How bacteria reproduce



Fortunately this never happens. As the mass of bacteria increases, food is used up. Less space is available. Wastes accumulate. Growth and reproduction slow down. Study these changes on the REPRODUCTION OF BACTERIA WORKSHEET.

REPRODUCTION OF BACTERIA WORKSHEET

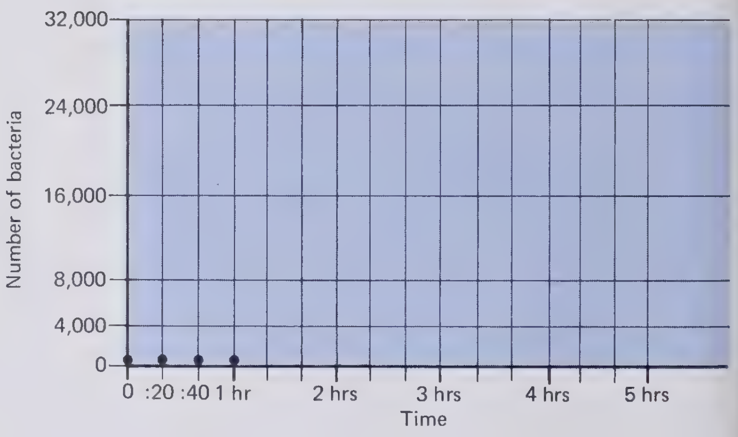
Bacteria divide every 20 minutes.

1. To find out how many bacteria one parent should produce in 5 hours, copy and complete the table below.

REPRODUCTION OF BACTERIA IN THEORY

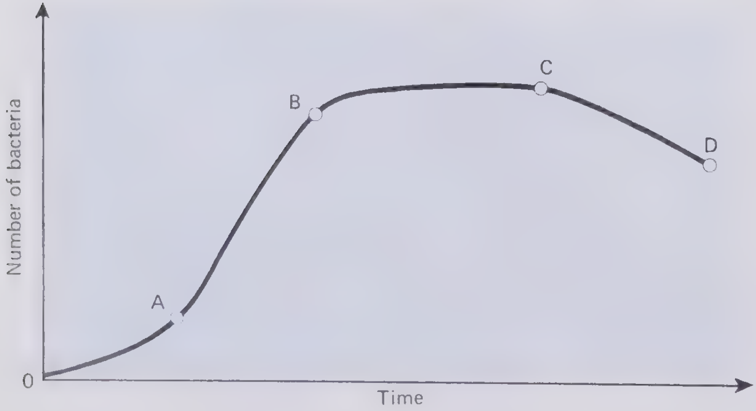
Time	Number of Bacteria
0 hr 00 min	1
0 hr 20 min	2
0 hr 40 min	4
1 hr 00 min	8
1 hr 20 min	
1 hr 40 min	
2 hr 00 min	
2 hr 20 min	
2 hr 40 min	
3 hr 00 min	
3 hr 20 min	
3 hr 40 min	
4 hr 00 min	
4 hr 20 min	
4 hr 40 min	
5 hr 00 min	

2. Using the figures in your table, draw a graph of Reproduction of Bacteria in Theory. Use the following as your model.



Study the following graph. REPRODUCTION OF BACTERIA FOR REAL.

REPRODUCTION OF BACTERIA FOR REAL



3. Describe how the growth of bacteria actually changes in the following stages of their reproduction:

a. "Getting started" stage	O—A
b. "Upbeat" stage	A—B
c. "Steady as she goes" stage	B—C
d. "Downbeat" stage	C—D

C. BACK TO MILK

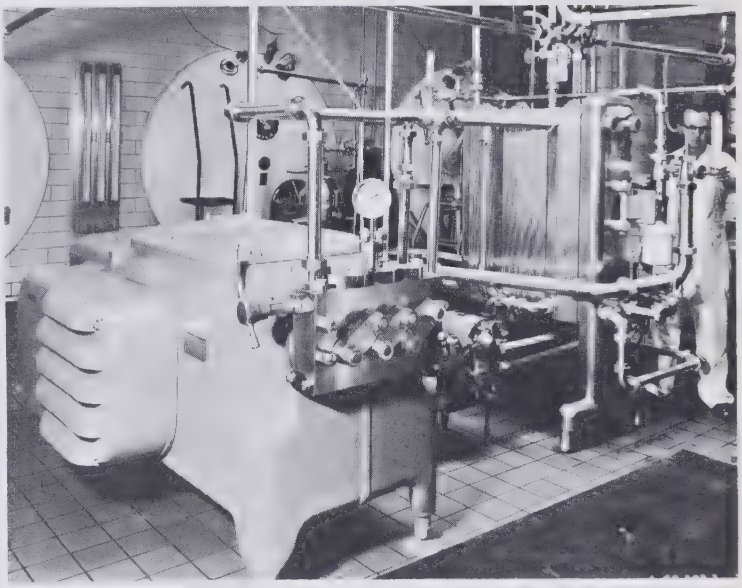
Let's apply what we have just learned about bacteria to milk.

Suppose bacteria in a milk carton reach their "upbeat" stage of reproduction. In a short time they can sour the milk. Soon afterwards, the acid which they themselves produce, slows their growth.

Milk from a cow is quite clean. Yet it does have some bacteria in it. It has some helpful ones and some harmful ones, maybe even some very dangerous bacteria that cause disease.

The milk has to be **pasteurized.** This means making it very hot for a very short period of time. The process kills the disease bacteria. However, it doesn't kill all bacteria.

Suppose pasteurized milk is kept too long at room temperature. This provides good conditions for people and for bacteria, but poor conditions for the milk. The bacteria enter their "upbeat" stage. The milk goes bad.



COURTESY NATIONAL DAIRY COUNCIL

This milk plant is spotless.

1. Why is milk pasteurized?

E. TESTING MILK

As the bacteria grow, they use up the oxygen dissolved in the milk.

You can add a dye, **methylene** blue, to the milk. Oxygen helps keep the blue color of the dye.

The faster the blue color fades, the less oxygen there is in the milk. That means there are lots of bacteria using up the oxygen.

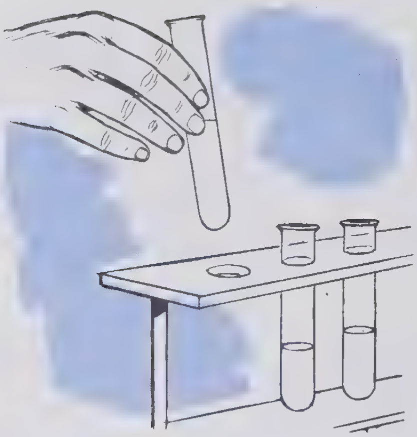
METHYLENE BLUE TABLE

Time for Loss of Blue Color	Freshness Rating of Milk
Less than 20 minutes	Spoiled: Very contaminated with bacteria.
20 minutes to 2 hours	Poor.
2 to 8 hours	Fair to good.
Over 8 hours	Excellent—very fresh.

2. Suppose the dye keeps its color for a long time. What do you know about the oxygen in the milk?
3. What do you know about the bacteria in the milk?

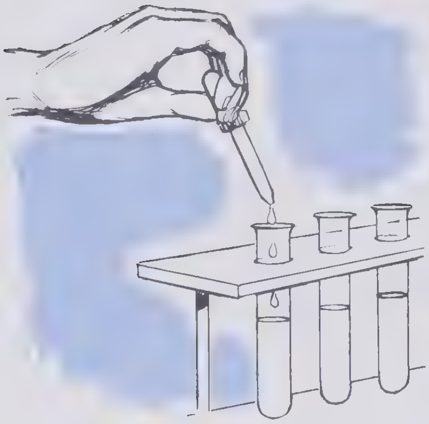
You will use methylene blue in the MILK TESTING ACTIVITY. With the help of the dye, you can tell fresh milk from milk that is about to spoil.

MILK TESTING ACTIVITY



A

The 3 samples of milk differ in their freshness. For each sample, fill a test tube $\frac{1}{3}$ full. Label the test tubes.

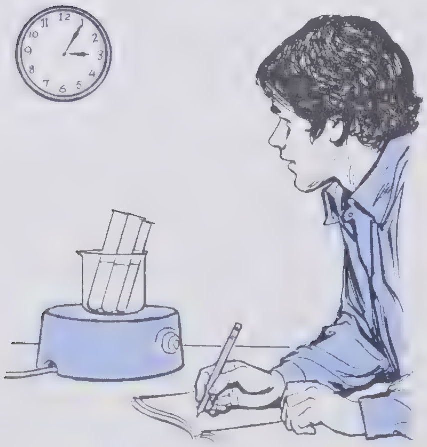


B

To each test tube add 20 drops of methylene blue solution.

C

Add a few drops of mineral oil to each tube to keep out extra oxygen.



D

Place tubes in a warm water bath. Record the time.

Test Tube Number	Time for Loss of Color	Freshness Rating of Milk
1		
2		
3		

E

Watch the tubes. Note when each tube loses blue color.

4. Which sample of milk was the freshest? How do you know?

5. Which sample was most likely to spoil? How do you know?

13 ACID MOUTH

word guide
fluoride
FLOO-uh-ryd
methyl
METH-uhl

PREPARATION—Bring your toothbrush and toothpaste to class.

One of the most important things a doctor or dentist can do for you is to tell you how to keep in good condition. General good health is the best defense against disease.

People who let themselves get run down are like fumblers on a football team. They are helping the opponents, the germs of disease.

A. MOUTH HEALTH

Keeping a healthy mouth is a good defense against disease.

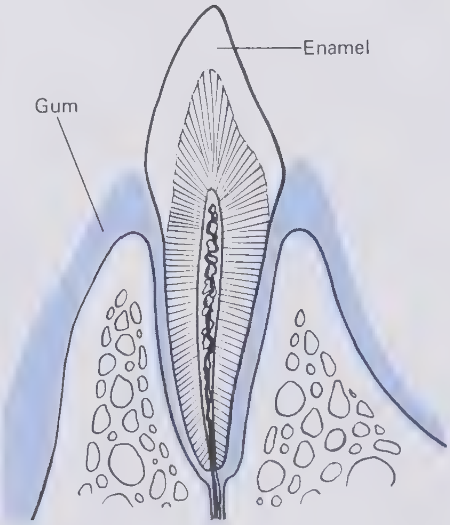
Teeth seem hard and tough. They are covered with very hard enamel. Actually they are very delicate. The inside of a tooth is living and soft.

Many bacteria live in the mouth. Most are harmless.

But some are harmful. They live on sugar. When you eat sweets, these bacteria quickly turn sugar into acid.

A sticky, acid coating forms on the teeth. Under the coating the acid eats cavities into the teeth. Eventually the coating forms hard tartar which only a dental hygienist or dentist can scrape off.

Mouth bacteria can also cause gum disease which loosens the teeth. Eventually gum disease can cause the teeth to fall out.

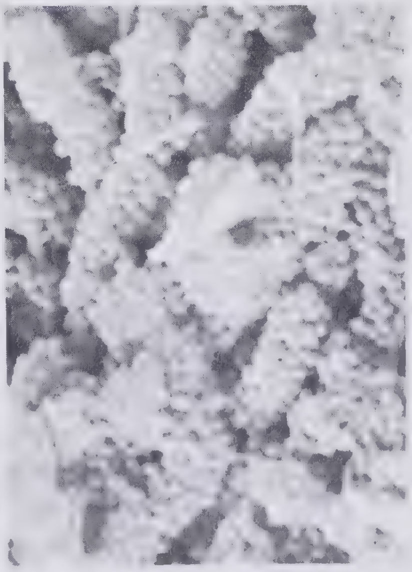


Structure of tooth

B. TESTING FOR MOUTH BACTERIA

Sugar and **methyl** red indicator are used to test for harmful mouth bacteria. If these bacteria are present, they feed on the sugar. They quickly produce acid.

Acid makes the indicator turn bright red. The red color is a danger signal. It means: HARMFUL BACTERIA AT WORK. BRUSH THOSE TEETH! CUT DOWN ON THAT SUGAR!



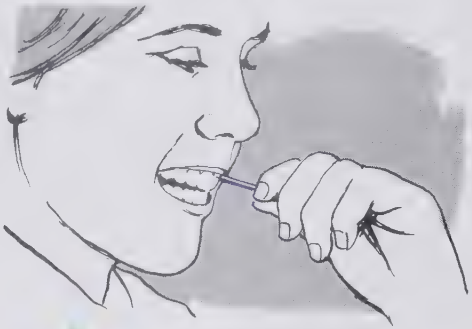
DR. Z. SKOBE, FORSYTH DENTAL CENTER

These mouth bacteria grew 3 days after tooth brushing stopped.

Test your own mouth bacteria in the ACID MOUTH ACTIVITY.

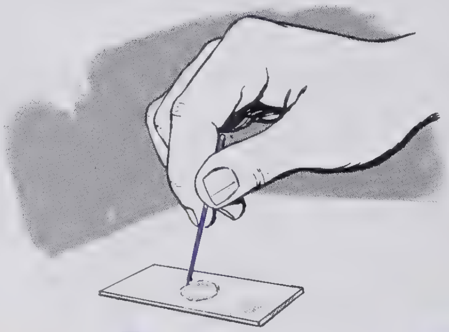
ACID MOUTH ACTIVITY

SLIDE TEST



A

With a clean toothpick, scrape some material from between your teeth.



B

Make a small ring of the material on a slide.

TOOTH TEST

F

Rinse your mouth with a weak sugar solution.

G

Apply methyl red to several teeth.

2. Why did you rinse with a sugar solution?

H

Watch for red color.

3. How does the acid produced by bacteria affect the teeth?

K

Again test with methyl red.

L

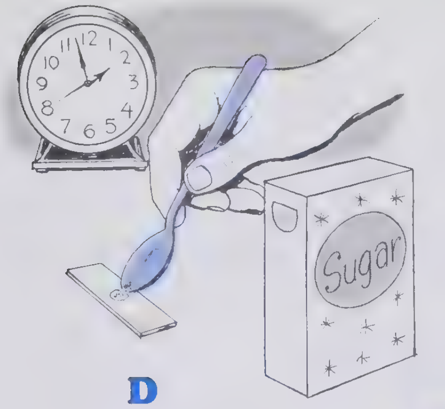
Check for red color.

4. What effect did brushing with water have?

5. What effect did brushing with toothpaste have?

C

Add 2 drops of methyl red indicator.



D

Add a few grains of sugar. Note the time.

E

Watch for red color. If it appears in seconds, you have too many acid-forming bacteria. The longer it takes for the red color to appear, the fewer bacteria are present.

1. When the indicator turns red, this means that fermentation of ____ has produced ____. The fermentation is caused by ____.

TOOTHBRUSH TEST

I

Brush teeth on one side with water.

J

Brush other side with toothpaste.

EXTRA

M

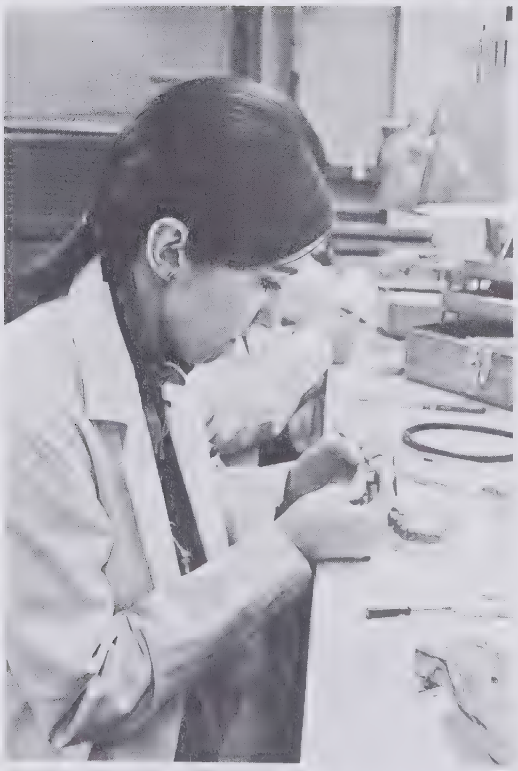
Make a smear of material from between your teeth. Stain it as in BEAN SOUP ACTIVITY. Examine it with the microscope.

6. What kind of bacteria did you find in your mouth? Name, draw, or describe them.
7. What is the good of brushing your teeth after meals?
8. Why are dentists unhappy with people who eat a lot of sugar?

C. SAVING YOUR TEETH

You can do several things to keep your teeth healthy. Cut down on sweets and between-meal snacks. Brush your teeth every time you finish eating. If possible, drink water to which **fluoride** has been added. See the dentist regularly. The dentist will scrape off tartar, fill cavities, replace missing teeth, and treat your gums if necessary.

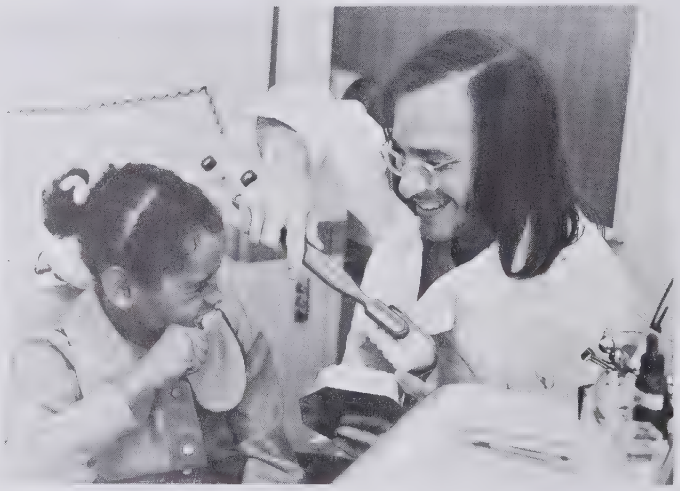
Thorough cleaning job



Dental technician

DAN BURNSTEIN/COURTESY TUFTS UNIVERSITY

JUDITH BORMAN HARDING, B. B. M. ASSOC.



Learning young

The dentist doesn't work alone. Dental assistants and hygienists help at the chair.

Dental technicians work in a dental lab. They build tooth replacements.

9. What did the dentist do on your last visit?
10. What assistants did the dentist have?

14

DO GERMS HAVE PARENTS?

A. COLONIES IN THE DISH

A **Petri** dish can help you find and grow germs. The dish contains food mixed with sticky **agar.**

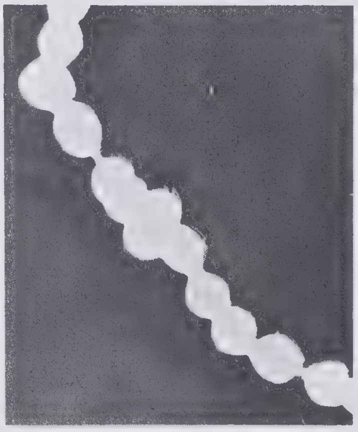
Bacteria grow well on agar. Molds and yeasts also grow well on agar. So there may be some molds and yeasts in the dish.

A germ that happens to land on the agar cannot swim away. When it reproduces, its offspring stay in the same spot. They form a **colony.**

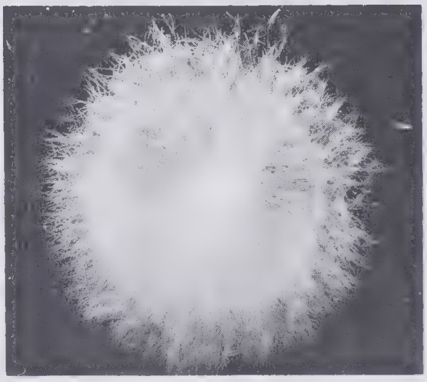
Colonies of bacteria have sharp edges.

Mold and yeast colonies are fuzzy and spreading.

Nobody can see a single germ. But a whole colony can easily be seen. Suppose you count the colonies. Since each colony came from a single parent germ, you will know how many single germs originally landed in the dish.


E. R. SQUIBB AND SON

Chain of bacteria will form a colony.

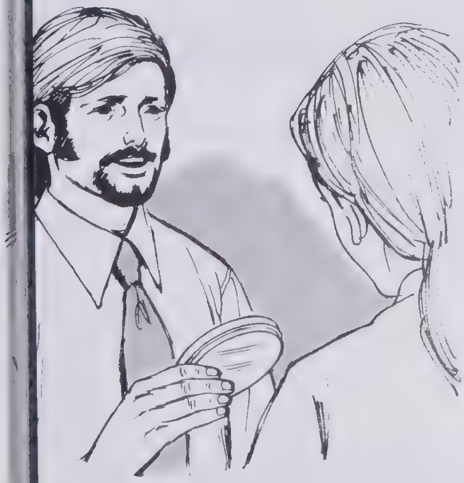

CAROLINA BIOLOGICAL SUPPLY CO.

Mold colony

word guide

agar	*AY-guhr*
colony	*KOL-uh-nee*
incubate	*IN-kyoo-bayt*
inoculate	*in-OK-yew-layt*
Pasteur	*pas-TUR*
Petri	*PEE-tree*
Spallanzani	*spah-lahn-ZAH-nee*

PETRI DISH ACTIVITY



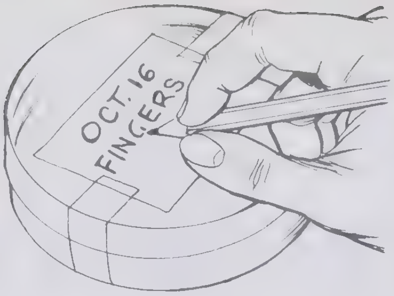
THREE DAYS AHEAD

A

Get a Petri dish containing nutrient agar. Don't open until ready to use.

B

Lift the cover just enough to get your hand in. Lightly press 4 fingers on the agar.

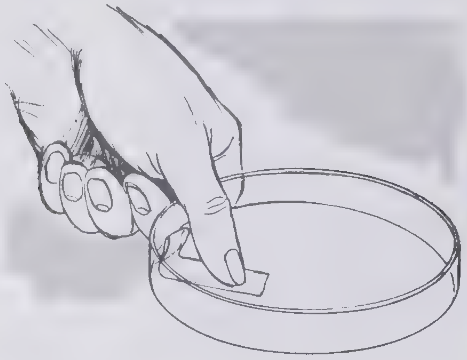


C

Seal the Petri dish. Label it.

D

Or put a few drops of drinking water, swimming pool water, milk, or other liquid in the Petri dish. Tilt dish to spread liquid. Seal and label.



E

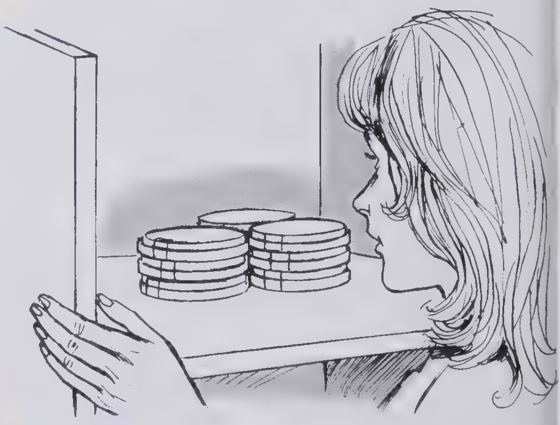
Or use sticky cellophane tape. **Inoculate** dish with germs from books, clothing, walls, or other surfaces. Seal and label.

F

Or use sterile wire loop to inoculate dish with dust or other material. Seal and label.

G

Leave several dishes unopened in the class. Label CONTROLS.



H

Incubate all dishes upside down in the dark, in warm room or incubator.

DAY OF THE ACTIVITY

I

Examine and count colonies in each dish. Record counts. Do not open dishes.

1. How did the colonies of germs in your Petri dish differ in appearance?
2. Make a map of your Petri dish. Label the colonies of bacteria and the colonies of molds.
3. From which source did your group get the most bacteria?
4. Where did each colony of germs come from?
5. What do the control dishes tell you?

B. LIFE FROM THE LIFELESS

For hundreds of years people argued about where germs come from.

Some said that germs come from dirt. If that is so, your colonies must have come from specks of dirt, not from parent germs that landed in the dish.

The same people said that live worms come from lifeless horsehairs.

They also claimed that mud produces living frogs. Have you ever heard these things?

Look, the mud is making frogs.

C. LIFE FROM LIFE

Others disagreed. After all, they said, kittens come from cats. Plants come from seeds. Seeds are made by parent plants. People come from mothers and fathers.

So, it appears that life comes only from life. Therefore, germs must come from germ parents. Your colonies couldn't have come from specks of dirt.

D. SETTLING THE ARGUMENT

Lazzaro **Spallanzani** was an 18th century Italian professor. He did an experiment to investigate whether germs must have parents.

Spallanzani knew that dust in the air carries germs. He also knew that corks are not airtight.

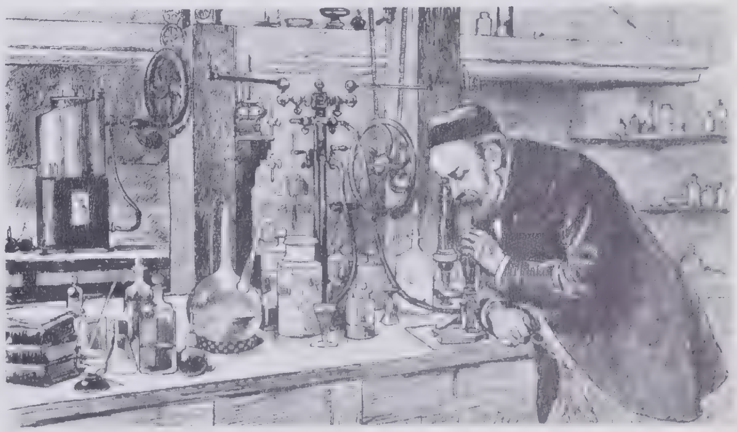
BROWN BROTHERS

Lazzaro Spallanzani

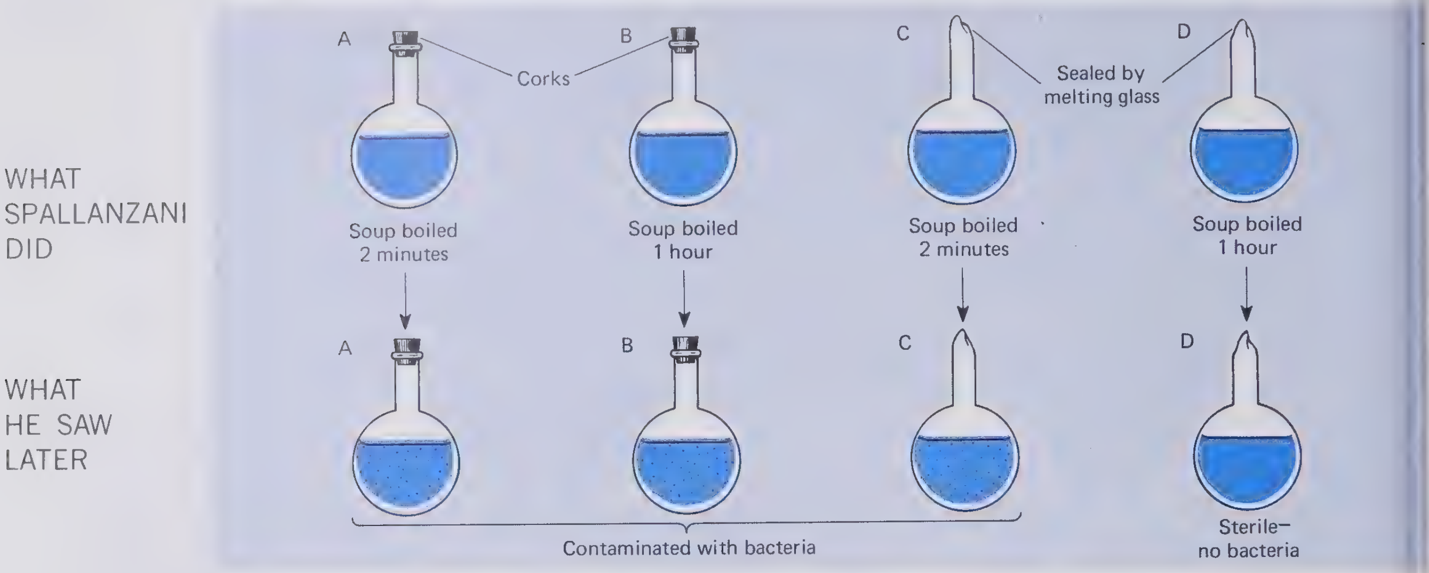
He cooked some soup and put it in several glass bottles. He sealed the bottles in different ways. Later he opened the bottles and looked in them for germs.

A century later, in France, Louis **Pasteur** tackled the same problem.

Louis Pasteur


CHARLES PFIZER AND CO., INC.

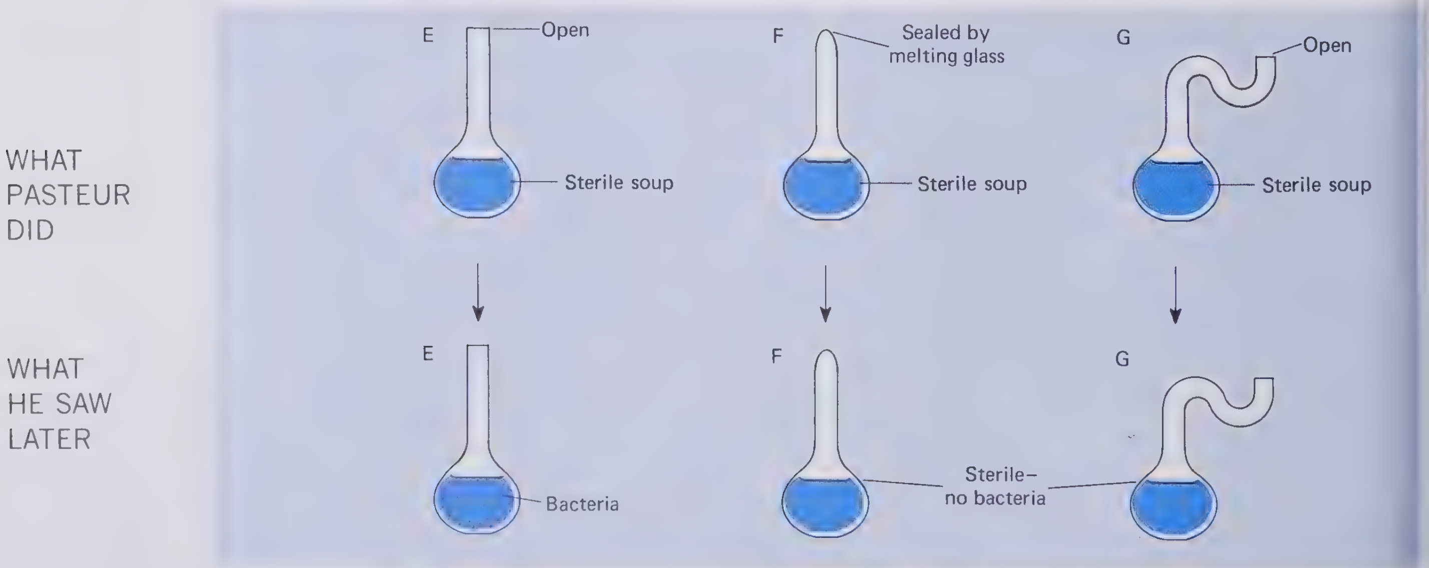
Study their experiments and see if you can answer the questions.



6. What effect did boiling have on the bacteria?
7. What effect did the corks have?
8. What was the effect of sealing the bottles?
9. Why were there no bacteria in bottle D?
10. How did Spallanzani's experiment help answer the question: Must germs have parents?

Some scientists still didn't agree. They believed that for bacteria to come from the lifeless soup, air must be present.

Pasteur tried to find out who was right.



11. Why were there bacteria in bottle E?
12. Why was bottle F sterile?
13. Why was bottle G sterile?
14. What is your conclusion: Must germs come from parents? Or can they come from lifeless soup or dirt?

15 GRASS OF THE SEA

PREPARATION—Check any trees you pass on the way to school. Look for a smooth, green growth on the north side of the trunk. Scrape off a little of the growth. Bring it to class.

word guide

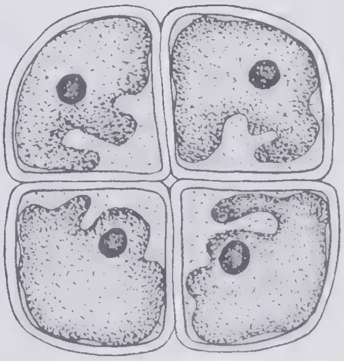
algae	*AL-jee*
diatom	*DY-uh-tom*
protococcus	*proh-toh-KOK-uhs*
spirogyra	*spy-ruh-JY-ruh*

The smooth, green growth is called **protococcus** or "tree green." It is a simple, one-celled plant.

Protococcus doesn't look like much. But it belongs to a mighty important group, the **algae.**

Algae are the simplest green plants. Most of them live in water—either in the ocean, or in lakes and rivers. Protococcus is one of the few algae living on land.

Algae make all the food that fish and other water animals live on. They produce most of the oxygen that you breathe. Now you see why little protococcus has some big-time relatives.



PROTOCOCCUS

A. TREE GREEN

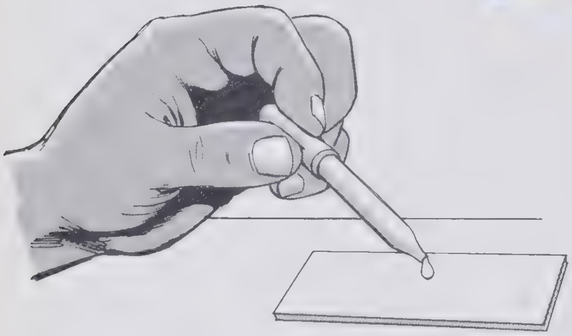
Like its relatives, protococcus needs moisture. That is why it must grow on the shady side of a tree, where the sun won't dry it out.

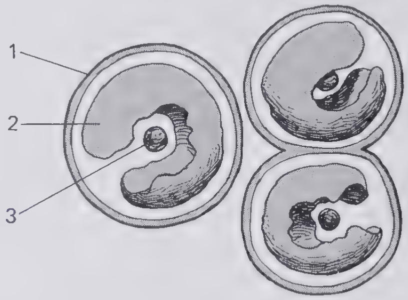
A lot of protococcus cells make up the green growth. But each cell is independent in itself. It takes care of all its own needs.

Each cell is enclosed in a thick wall that helps protect it from drying out. Inside the wall are the cell membrane, cytoplasm, and nucleus that you find in all cells.

Remember that protococcus is an independent plant cell. It contains green chlorophyll. With this all-important dye, it makes food for itself and for the creatures that feed on it.

PROTOCOCCUS ACTIVITY





A

Make a slide of protococcus in water.

B

Examine the slide with the microscope.

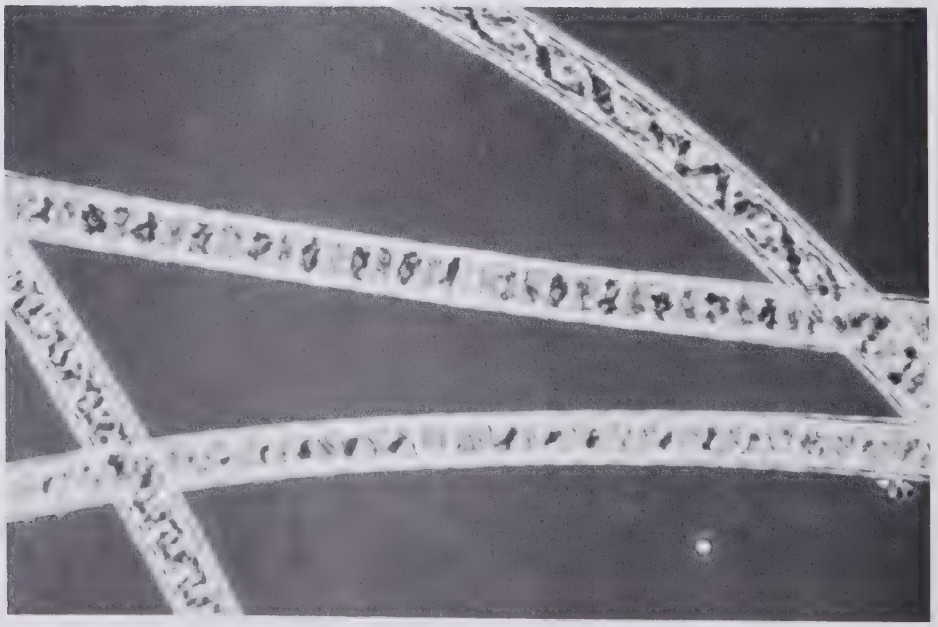
1. Draw protococcus and label the numbered structures.

2. How do you explain protococcus surviving on land, while most of its relatives live in the sea?

3. What structures in protococcus have you already seen in other cells?

B. THE LIVING SCUM

Pond scum or **spirogyra** is a slimy green growth that covers the surface of ponds. Under the microscope the scum looks like a tangle of threads.



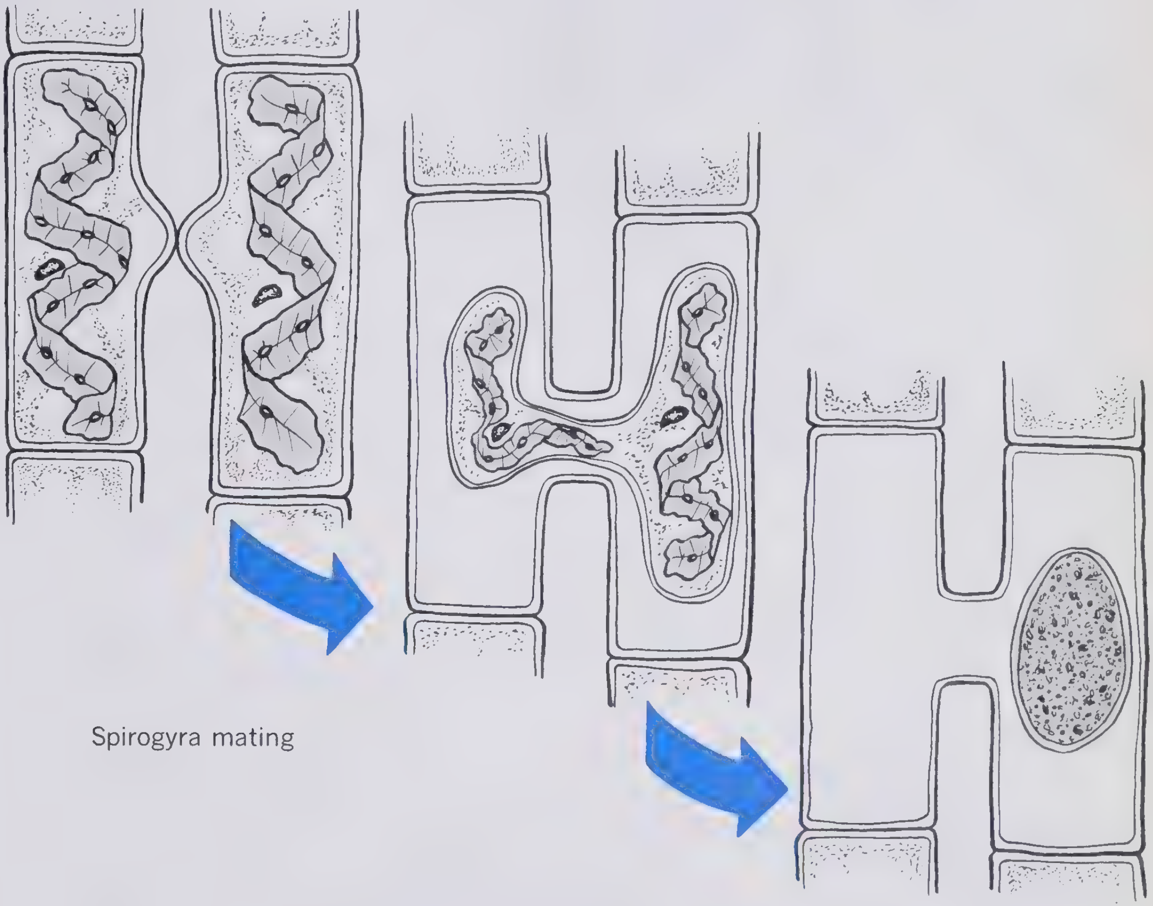
Spirogyra magnified

WARD'S NATURAL SCIENCE ESTABLISHMENT, INC.

Each thread is a string of cells, like the cars in a subway train. The individual cells of this alga have 2 interesting features.

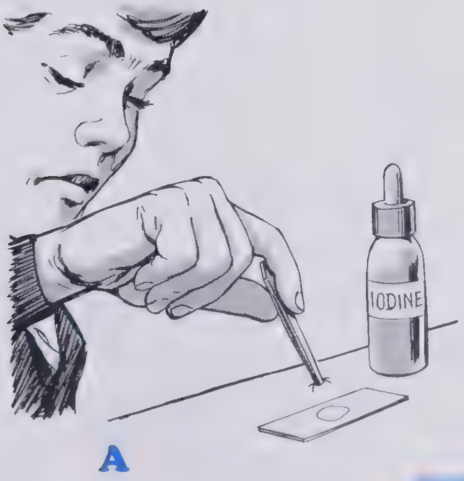
The cholorphyll is found in a ribbon-like chloroplast that winds around inside the cell.

Spirogyra has sex. When 2 threads mate, a cell from one thread joins with the opposite cell from the other thread. Later, a new, baby spirogyra thread can develop from the joined cells.

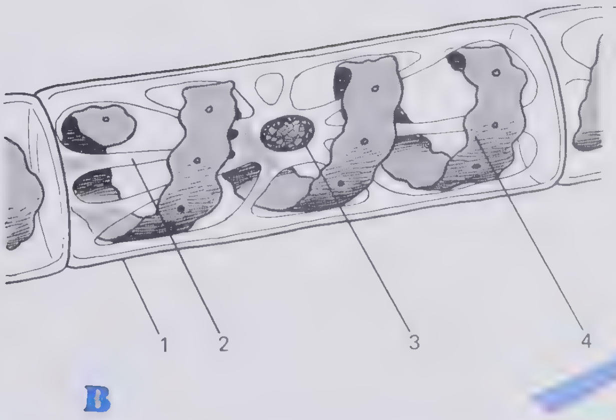


Spirogyra mating

SPIROGYRA ACTIVITY

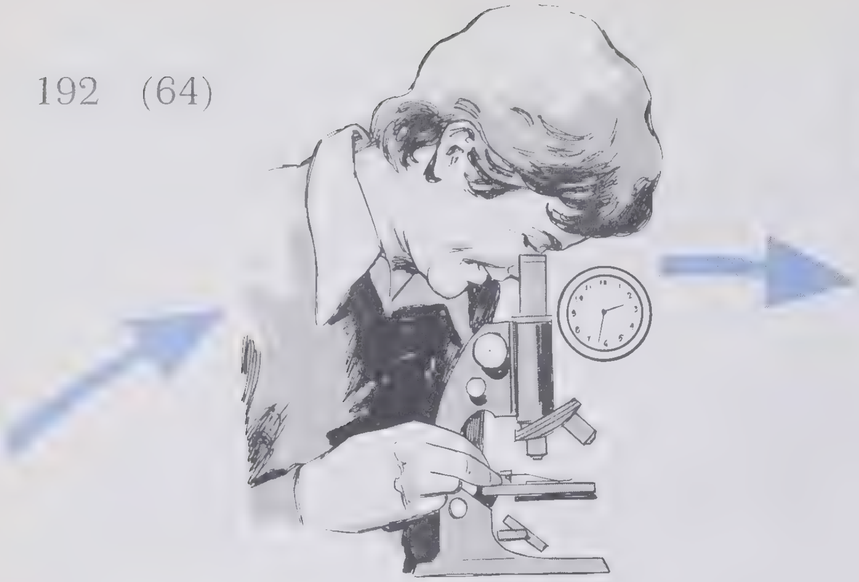


Put a drop of iodine on a slide. Add some spirogyra threads.



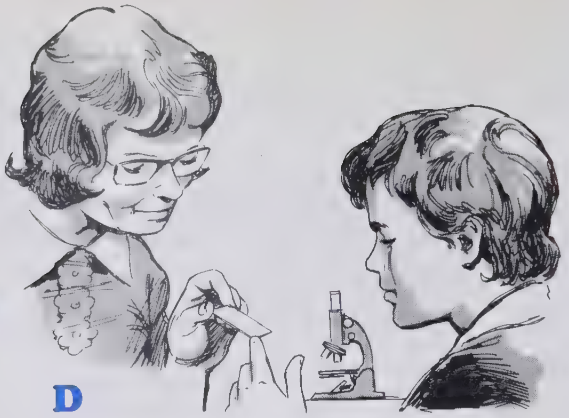
What parts of the spirogyra cell can you identify?

4. Draw a spirogyra cell and label the numbered structures.



C

Watch for color developing in the spirogyra cell. This may take 10 minutes.



D

By examining a slide, figure out how spirogyra threads mate.

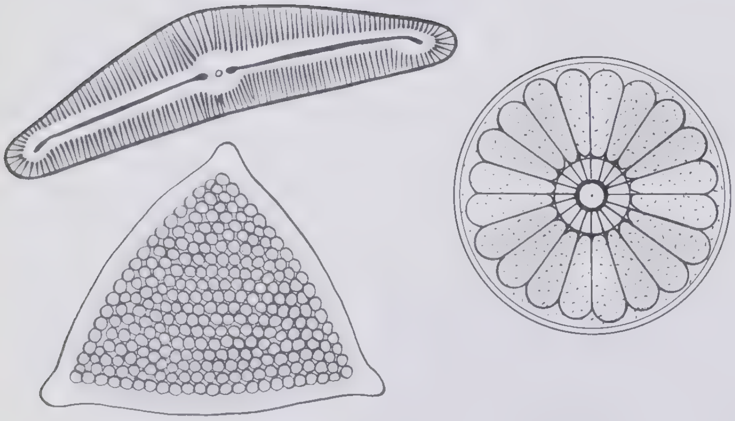
5. How do you think spirogyra got its name? (HINT: Compare the name with the word "spiral.")

6. In what part of the spirogyra cell is food stored? (HINT: Recall the iodine test for starch.)

7. What reason can you see for calling spirogyra threads male or female?

C. AT LAST THE GRASS

The most important algae are the smallest. They are strange, pretty, one-celled plants called **diatoms.**



Each diatom is enclosed in a shell. The shell is built like a box with a top half and a bottom half. The shell has designs on it.

You can watch a living diatom creep across your slide. It has no legs or cilia, and no one knows how it moves.

Diatoms are the most abundant algae in the sea. They even grow in the icy Arctic Ocean where no other plants are found. Diatoms provide food for all animals of the sea, from the littlest fish to the mighty whale.

DIATOM ACTIVITY

Study a diatom slide.

8. Draw the designs of your diatoms. Do any of your neighbors have the same designs?

9. Explain the title of this chapter. (HINT: Remember the diatoms!)

ECOLOGY

CONTENTS

ECOLOGY

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1 LIFE IN A DROP OF WATER

word guide

decayer	*di-KAY-uhr*
ecology	*ee-KOL-uh-jee*
fungi	*FUN-jy*

You expect to see fish in a fishtank. But fishtank water also contains other living creatures.

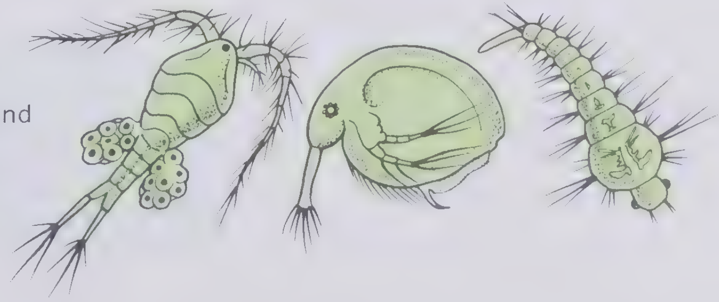
Suppose you examine a few drops of fishtank water. You will see many interesting forms living together.

A. THE BIG GUYS

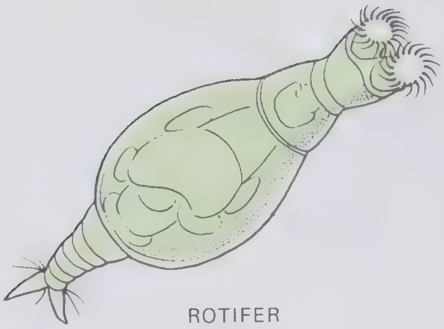
You will not need a microscope to see the larger creatures. The water plants in the tank are complex and many-celled. They are seedplants.

The few fish that live in the tank are also complex.

The smaller animals might include baby insects, roundworms, or crustaceans. These creatures eat other small living things in the water.

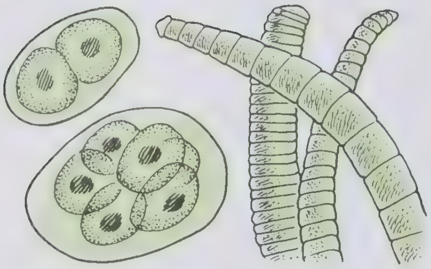


Two crustaceans and a baby insect


ROTIFER

Under the microscope you will probably see little rotifers. There are structures on the heads of these animals that look like wheels turning. The wheels are actually rings of small hairs or cilia. The cilia beat food into the mouth. Watch the food go down.

B. ALGAE, THE LITTLE GUYS


ALGAE

You will also see algae, the simplest plants. These plants have no flowers, stems, roots or leaves. They just have an arrangement of cells, all very much alike. Algae generally live in water.

The algae in the tank are very small. However, some seaweeds, which are also algae, are 60 meters (200 feet) long. Do you like the feel of ice cream in your mouth? A product from seaweed makes ice cream feel smooth.

Algae come in many colors—reddish, blue-green, green, golden brown. There is always some of the green dye, chlorophyll, in algae but it is sometimes hidden by other colors. Chlorophyll helps algae to make their own food out of sunlight, water, and gas.

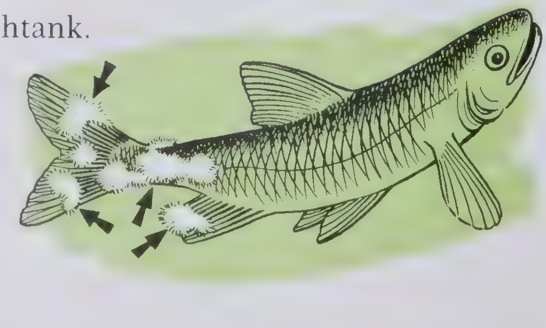
1. What will help you recognize algae?

C. FUNGI, THE DECAYERS

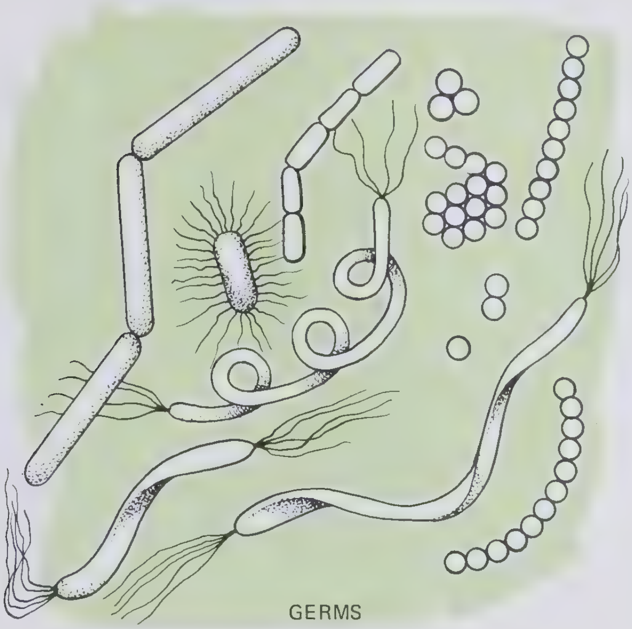
Fungi are also simple plants like algae. Fungi may be black, white, brown, or yellow. They may even look greenish, but they never contain chlorophyll.

Because of this, fungi cannot make their own food. Instead they take in food from other plants or animals, or they live on dead material and make it decay.

Some harmful fungi that grow on living plants and animals are called molds. They cause disease. In human beings "athlete's foot" is a mold disease. Water molds sometimes attack fish in a fishtank.


Water mold growing on fish

Germs or bacteria are the smallest fungi. They look like floating or moving dots. Like other fungi, bacteria are **decayers.**



GERMS

2. If fungi are decayers, how does this make them useful?
3. What will help you recognize fungi?

D. THE SCOOTERS

One-celled animals scoot through the water. They have many different shapes. They eat algae, bacteria, and even each other.

Wherever there is water, there are one-celled animals. One of these animals is most at home in sewage.

E. EVERYTHING IS CONNECTED

One-celled animals, algae, or rotifers are never found in water alone. They all live together. They depend on each other. The plants make food for the animals. The animals eat the plants, and supply what the plants need.

This is true everywhere, not just in a drop of fishtank water. In nature, everything is connected to everything else.

The study of how living things are connected to each other, and to their surroundings, is called **ecology.** This unit is about ecology.

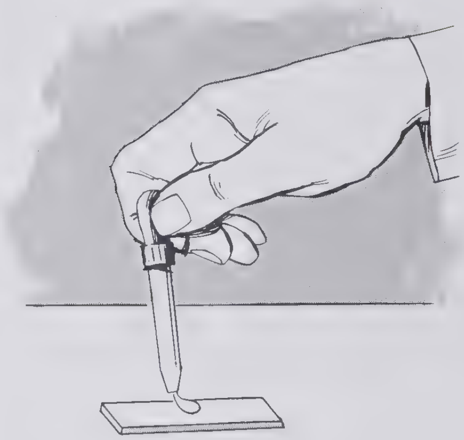
People are also discussed in this unit. We, too, are connected to other living things, and to our surroundings.

4. In your own words, what is ecology?
5. Give an example showing how everything in nature is connected.

DROP-OF-WATER ACTIVITY

A

Take some water from the fishtank.



B

Examine the water with a microscope.

C

List the living things you find in the drop of water. Use the pictures in the chapter as a guide. Look for:

- algae
- fungi
- bacteria
- one-celled animals
- rotifers
- other many-celled animals

D

Look for living things in other kinds of water. Try:

- pond water
- puddle water
- ditch water
- water from flower vases
- water you have soaked mud or plants in
- any other kind of water you can think of.

Keep the water in jars like these.

E

Give the creatures in the jars a few days to settle down. Set up your microscope and go hunting.

2 THE WORLD IN THE SOIL

You find sand at the beach and in the desert. Notice how white the sand is. Little grows in it.

STANDARD OIL COMPANY

Ground in which crops can grow is called soil. The farm pictured below has dark rich soil.

USDA SOIL CONSERVATION SERVICE

word guide

community	*kuh-MYOO-nuh-tee*
consumer	*kuhn-SOOM-uhr*
decomposer	*dee-kuhm-POHZ-uhr*
microbe	*MY-krohb*
microscopic	*my-kruh-SKOP-ik*
producer	*pruh-DOOS-uhr*

A. SAND AND SOIL

Sand is made up of ground-up bits of rock.

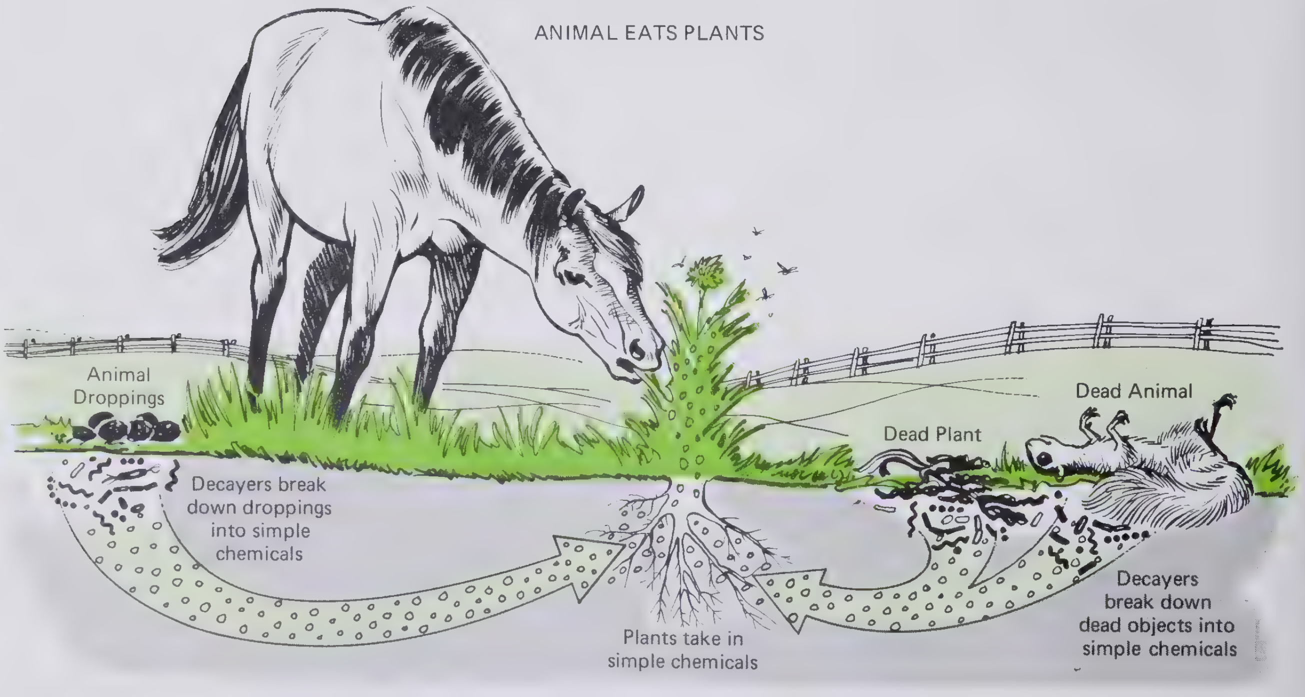
Soil also contains ground-up bits of rock. But where sand is dead, soil is full of life.

Take a piece of soil as big as a city block. Plants grow in it. The plants produce food. These plants are called **producers.**

Several million earthworms may live in the block of soil. Also living there are roundworms, insects, spiders, and a whole zoo of tiny animals. The animals eat plants and each other. These eaters are called **consumers.** In time, every plant and animal dies.

B. THE SOIL COMMUNITY

The same block may contain 45 metric tons of **microbes**—bacteria, molds, and one-celled plants and animals. Many of these microbes are decayers, also called **decomposers.** They cause the dead plants and animals to decay or decompose into simple chemicals.


ANIMAL EATS PLANTS
Animal Droppings
Dead Plant
Dead Animal
Decayers break down droppings into simple chemicals
Plants take in simple chemicals
Decayers break down dead objects into simple chemicals

The decaying materials are taken in by plants. They feed the new plant growth. They make the soil dark and rich.

The producers, consumers, and decomposers all belong to the soil **community.**

You have studied another kind of community—the community in a drop of water. All living things live in communities. All communities contain producers, consumers, and decomposers.

C. FINDING LIFE IN THE SOIL

Examine some soil. You can find life and the remains of life.

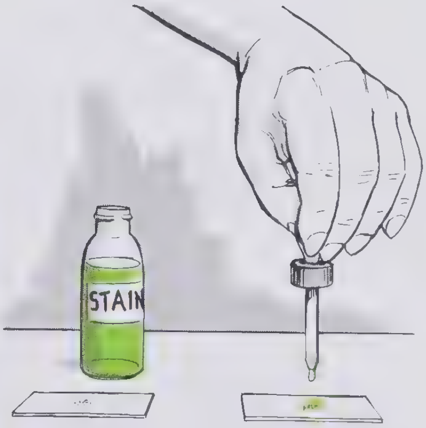
You are sure to see **microscopic** roundworms. Many of these roundworms feed on the roots of plants. They are consumers.

Roundworms move in an odd way. Their muscles all run up and down their body. They have no muscles running around their body, as you have.

SOIL-ANIMALS ACTIVITY

A

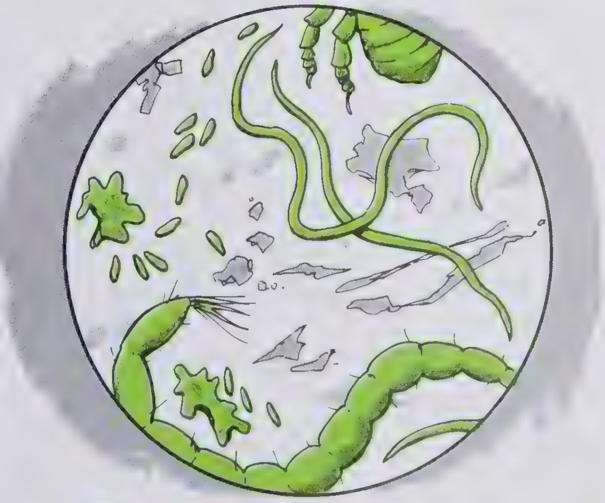
Spread a little sand on one slide and a little soil on another slide.



B

Stain both slides lightly.

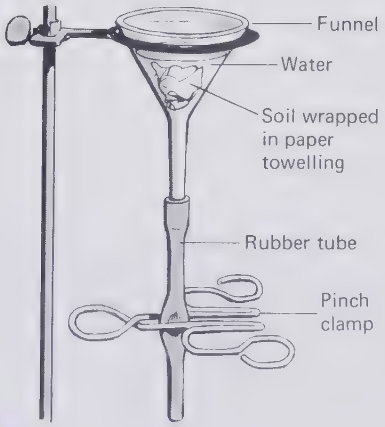
1. What is the difference between sand and soil?



C

Living creatures and their remains will be colored.

2. Draw or describe some of the living things you find.

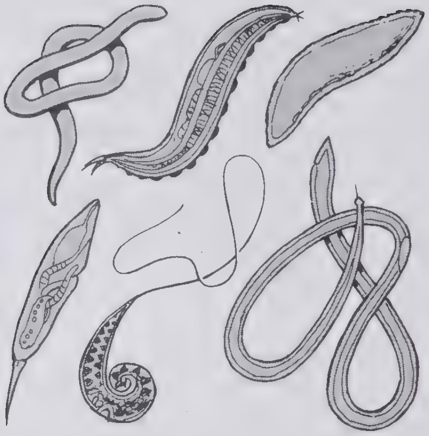


D

Water will wash roundworms out of the soil in this worm trap.

E

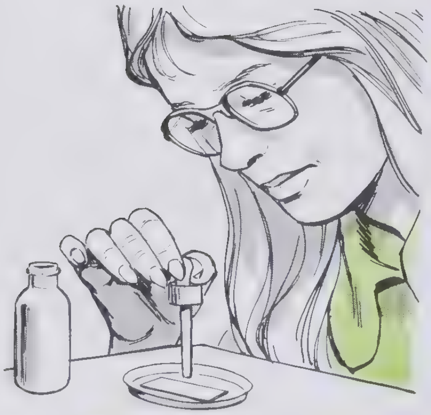
Open the clamp carefully. Run a few drops of water into a dish.



F

Find some roundworms. The females have long, pointed tails. Find their eggs.

3. How do roundworms move?



G

Put a little dye in the water. Watch the roundworms feed.

H

Feed the worms some brilliant green stain. This changes color as food is digested.

4. What evidence did you see of digestion in the roundworm?

5. What else did you find out about roundworms?

6. Explain the differences among producers, consumers, and decomposers.
7. What do we mean by a community of living things?

3 NIGHT CRAWLER

word guide

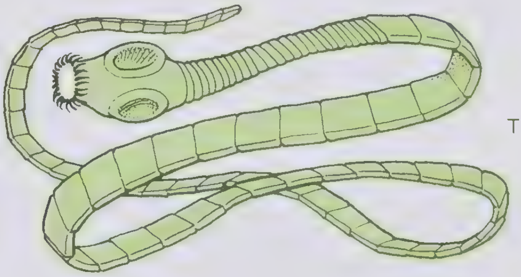
fertilizer	*FUHR-ti-ly-zuhr*
parasite	*PAR-uh-syt*
segment	*SEG-muhnt*

There are many different kinds of worms. They belong to several of the main groups of animals. You have already studied roundworms, which are very common in the soil.

A. FLATWORMS

Tapeworms belong to the flatworm group. Many flatworms are **parasites.** Parasites latch on to some other plant or animal, and live from it.

Tapeworms are parasites in the intestine of man and certain animals. The tapeworm absorbs much of the food that the victim eats.



TAPEWORM

When you "worm" a dog, you get rid of tapeworms and other worm parasites.

1. How are tapeworms harmful?

B. THE EARTHWORM, A SEGMENT WORM

Earthworms are also called night crawlers. They burrow in the ground. When rain floods their burrows, they come to the surface to avoid drowning.

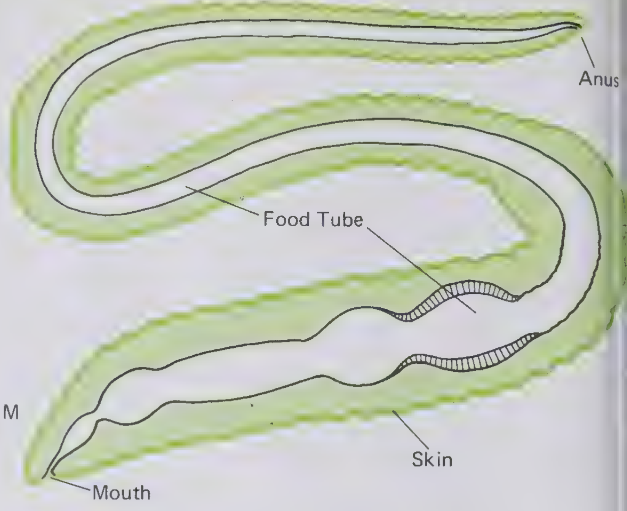
People go out with flashlights at night, or early in the morning, before the ground dries. They collect the night crawlers. The worms make good fish bait.

Earthworms belong to the **segment** worm group. Their body is made of segments or sections. The segments are linked together, in the way railroad cars are linked together to make a train.

The segments can stretch and shrink. This makes it easy for the earthworm to crawl and burrow. The earthworm is built for easy living in the ground in other ways also.

C. NATURE'S PLOW AND OUR FRIEND

The earthworm's body plan is something like ours. The worm's digestive system is a long inner tube, with a mouth at one end and an anus at the other.



EARTHWORM

The worm burrows by eating the soil in front of it. As the soil is squeezed down the digestive tube, the plant and animal matter in the soil is digested. The waste material left behind is good **fertilizer.** By burrowing, the earthworm plows the ground. Air and water can then soak in easily. Plants grow well in ground that has many earthworms.

2. Why is the earthworm called "nature's plow"?
3. Why is it a friend to human beings?

ALLAN ROBERTS

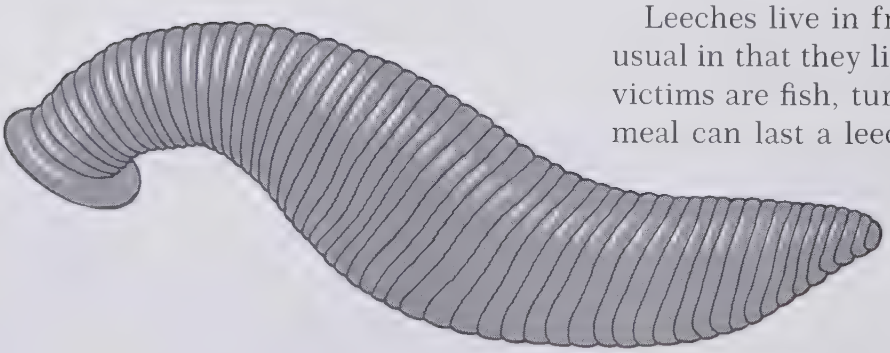
The earthworm is a complex little creature. It has a well developed circulation system around the digestive tube. Several pairs of hearts pump the blood. It even has a small brain.

Earthworms reproduce by mating. Each worm is both male and female. You can learn more about these creatures by doing the EARTHWORM ACTIVITY.

D. MORE SEGMENT WORMS

Many segment worms live in the sea. Sandworms, found on beaches, make good bait.

Leeches live in fresh water. They are unusual in that they live by sucking blood. The victims are fish, turtles, and mammals. One meal can last a leech for months.



LEECH

Leeches were once used on sick people to "clear their blood." However, doctors no longer believe in this idea.

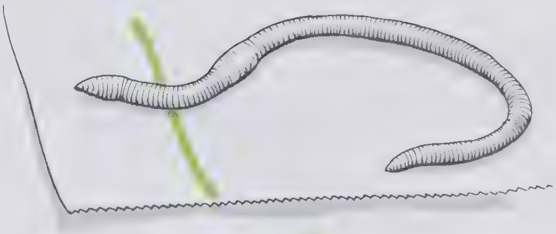
EARTHWORM ACTIVITY

LIVING EARTHWORM

A

Place earthworm on damp paper towel and watch it. The belt makes a cocoon that holds eggs after mating.

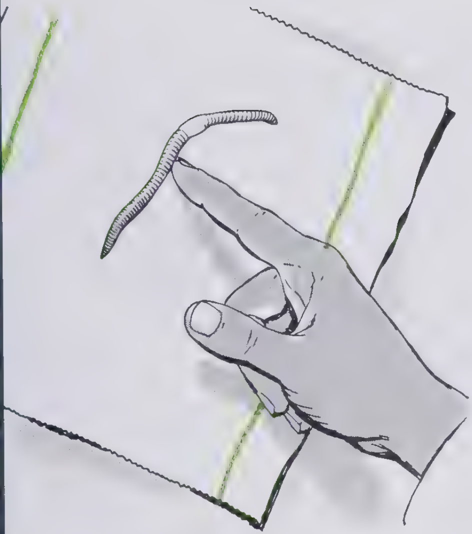
4. How many segments are there? Are they all alike?



B

Find mouth and anus.

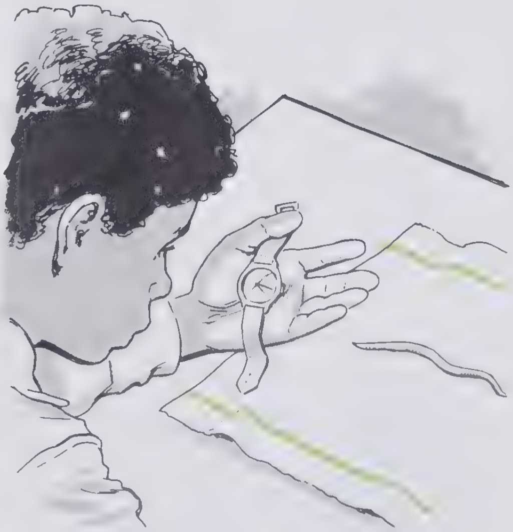
5. How can you recognize the front end and the tail end?



C

Run your finger along the earthworm's skin. Find the bristles.

6. Can you figure out how the bristles help the worm?



D

Find main vessel along the back. Note blood flow. Time the pulse rate.

7. Which way does the blood flow in the main blood vessel?
8. What is the pulse rate?

E

Test worm with the following: light, ice, warmth, and weak acid.

9. What is the earthworm sensitive to?

F

Put worm's head in a glass tube. Gently poke the tail.

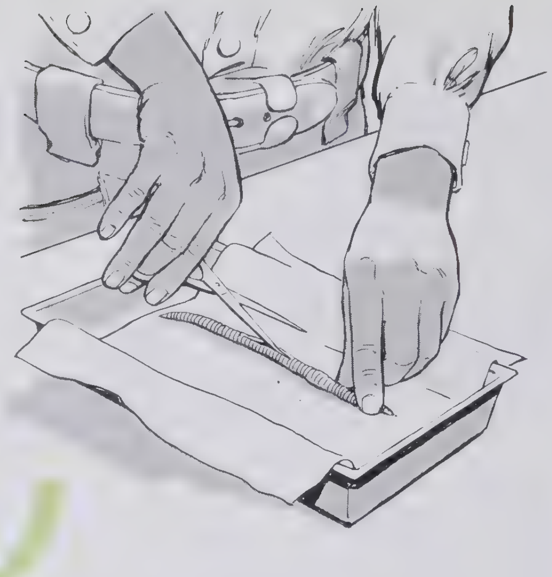
10. How does the worm crawl?

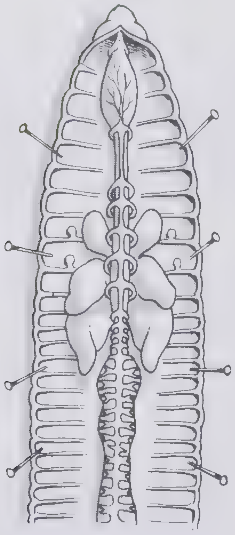
DISSECTING THE EARTHWORM

G

Lay preserved worm on paper towel in dissecting pan. Start 5 cm (2 inches) behind the belt. Cut skin up the back. Pin skin back.

11. How are the segments separated?

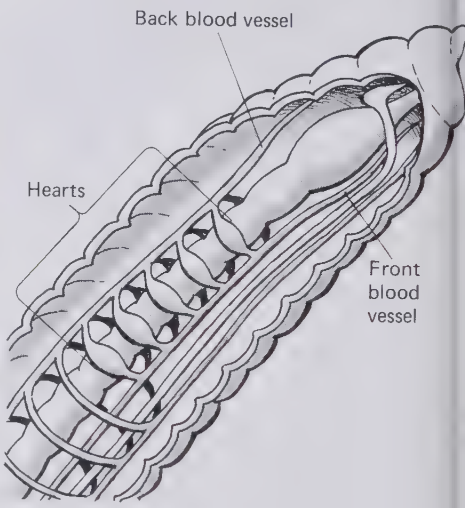




H

Find these parts of digestive tube:

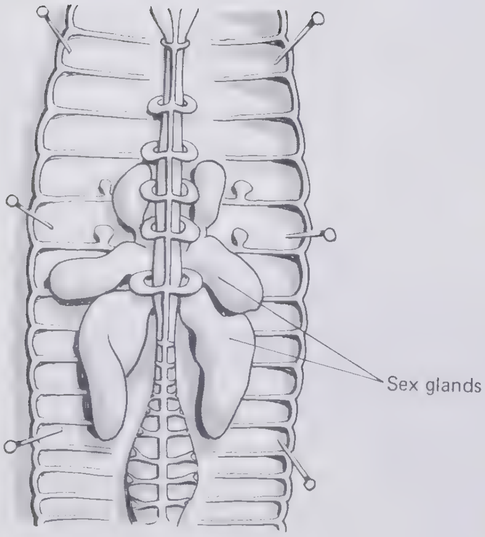
throat	hard gizzard
gullet	long intestine
soft stomach	



I

Find the hearts alongside the gullet.

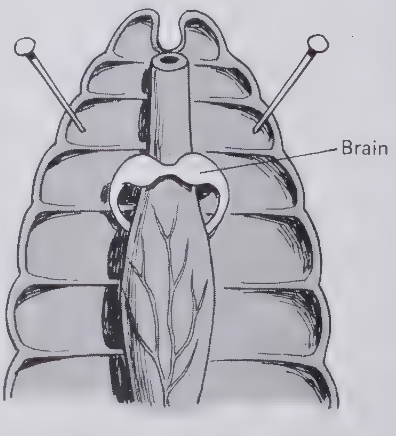
12. How many hearts are there? How are they connected?



J

Near the hearts are several sex glands.

13. Briefly describe the sex glands.



K

Find the whitish brain. It is in 2 parts, above and below the throat.

14. How is the brain connected to the rest of the body?

4 THE FOREST IN THE CITY

To talk of a forest in the city may seem strange. But plants grow all around us. Some are so small and hidden that we hardly even notice them. The mosses growing in cracks in the sidewalk are a good example of this.

word guide

ailanthus	*ay-LAN-thuhs*
forsythia	*fawr-SITH-ee-uh*
herb	*UHRB*
privet	*PRIV-it*
recycle	*ree-SY-kuhl*
sumac	*SOO-mak*

The green growth along the bank of a river is also a form of plant life. The brown coating inside the water tank in the bathroom is another form.

A. THE WEAK SISTERS

Mosses grow in damp cracks and in other wet places. They have no real roots or leaves, and no flowers. They have only weak little stems.

Mosses were the first green land plants. All the bigger, more complex land plants developed from mosses.

Ferns are bigger than mosses. They have stems, roots, and leaves. The stems of ferns have tubes that carry water through the plant. This helps ferns to live on land.

The ferns that you see are only a meter or so high. In Australia you might see tall tree ferns.

AUSTRALIAN NEWS AND INFORMATION BUREAU

B. FLOWERING PLANTS AROUND YOU

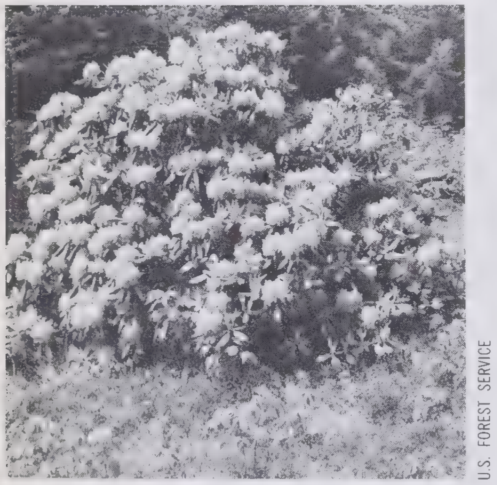
Most of the larger plants that you usually notice are called flowering plants.

There are a quarter million known flowering plants. They outnumber all other types of plant life. Flowering plants grow everywhere that human beings live. Very few grow in the ocean.

Some flowering plants are trees. The oak, elm, maple, ash, plane tree, basswood, and **ailanthus** are common city trees. The ailanthus is also called the "tree of heaven," or "the tree that grows in Brooklyn."

1. What trees do you see on the way to school?

Ailanthus



U.S. FOREST SERVICE

Rhododendron

Some flowering plants are shrubs or bushes. Examples are: **privet, sumac,** rosebushes, lilac, and **forsythia.**

2. Can you name any shrubs you have seen?

A few flowering plants are vines. Vines often climb on trees. Poison ivy, English ivy, tropical yams, and honeysuckle are vines.

C. WHAT'S AN HERB?

Most flowering plants are **herbs.** To a cook, an herb is a plant used to flavor food. But to a biologist an herb is any small flowering plant.

Weeds, such as milkweed and dandelion, grasses, most house plants, and most vegetables are herbs. Garden flowers, and flowers sold in shops, come from herbs.

3. Can you name a dozen different herbs?

Herbs

D. THE PLANT PLAN

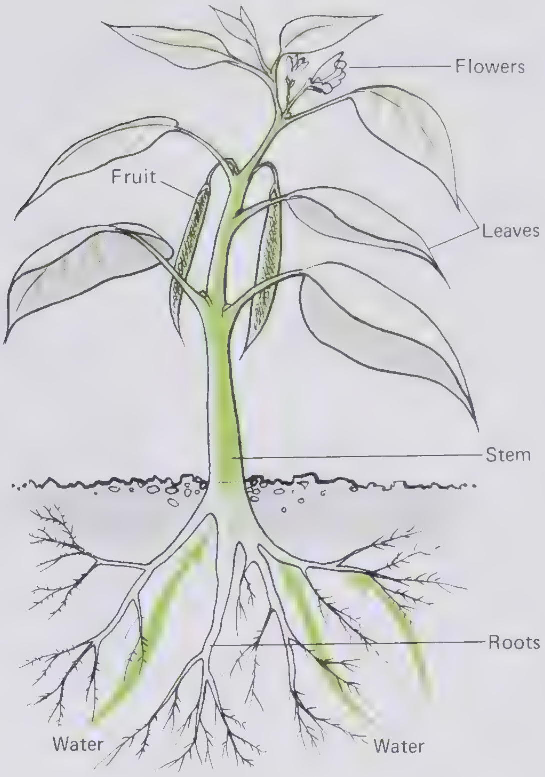
All flowering plants are built on the same plan.

They have roots which anchor the plant. The roots absorb water and minerals from the ground.

They have a stem, or several stems, which hold up the plant. The stem contains tubes which carry food and water.

They have leaves that use water, along with carbon dioxide gas and sunlight, to make food.

At a certain time, flowers develop. These flowers turn into fruits and seeds, which in turn reproduce the plant.



E. WHAT MAKES A TREE?

What makes an herb? Herbs are small and trees are big. Most herbs live only a year or two, while trees may live for hundreds of years. Yet herbs, shrubs, and trees are not so very different.

A great part of the difference depends on the stem. Tree trunks are stems. They are made largely of wood fibers. Shrub and vine stems have the same wood fibers, but fewer of them.

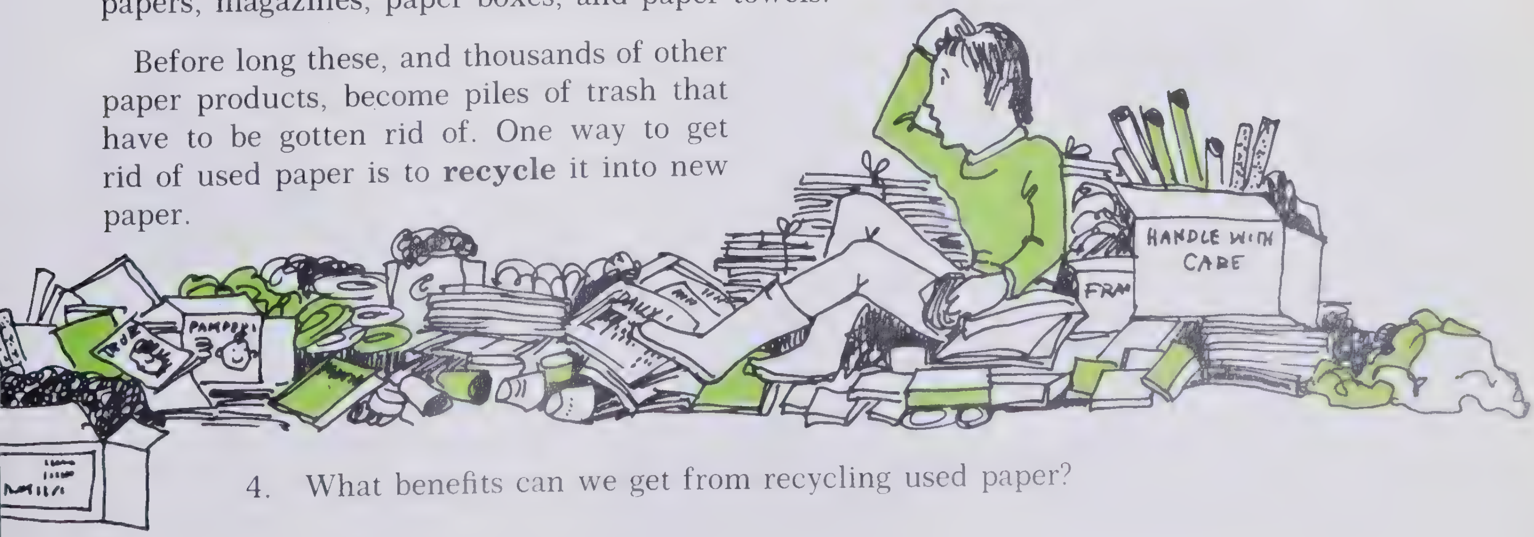
Herb stems have only a few wood fibers. They have just enough to hold up the plant, but not enough to make it very strong or tall.

F. THE PAPER TRASH PILE

Paper is made of wood fibers.

We cut down trees to get wood. From the wood we make newspapers, magazines, paper boxes, and paper towels.

Before long these, and thousands of other paper products, become piles of trash that have to be gotten rid of. One way to get rid of used paper is to **recycle** it into new paper.



4. What benefits can we get from recycling used paper?

In the PAPER-RECYCLING ACTIVITY you can make new paper from trash.

PAPER-RECYCLING ACTIVITY

A

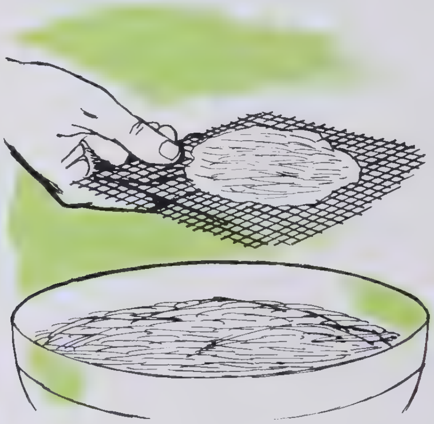
Tear a newspaper into small scraps. Soak the paper scraps overnight in a large bowl $\frac{1}{4}$ full of water.

B

Beat the paper scraps and water until you get a creamy mixture. (CAREFUL! Wear an apron. You are going to spatter.)

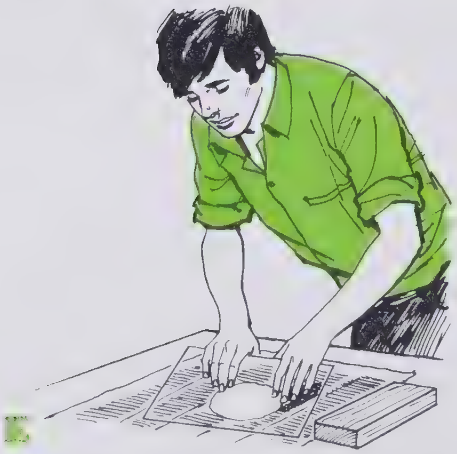
C

Dissolve 2 tablespoonfuls of starch in a pint of water. Stir into the bowl of paper pulp.



D

Dip screen into the mixture like this. Keep dipping until you get a thick layer of fibers on the screen.



E

Place screen on a newspaper. Cover fibers with a sheet of plastic and a block of wood. Squeeze out the water.

F

Let dry overnight. Then peel off the recycled paper. Try writing on it.

5 SOFTWOOD, HARDWOOD

word guide
cambium
KAM-bee-uhm

Hammer a nail into a piece of white pine wood. Then drive another nail into oak.

1. Which wood is it easier to drive the nail into?

Now you know why carpenters and lumbermen speak of hardwood and softwood. The 2 kinds of wood, pine and oak, come from 2 different kinds of trees.

A. EVERGREENS

Softwood comes from trees such as pines, firs, spruce, cedars, and redwoods. These trees are evergreens. They keep their leaves all winter. Their seeds grow in cones.

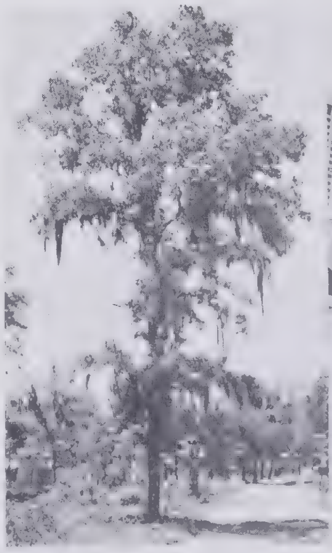
Evergreens have narrow, needle-like, waxy leaves with a nice smell. Christmas trees are evergreens.

Building lumber and paper come mainly from softwood or evergreen trees.

2. Why do evergreens make good Christmas trees?

B. HARDWOODS

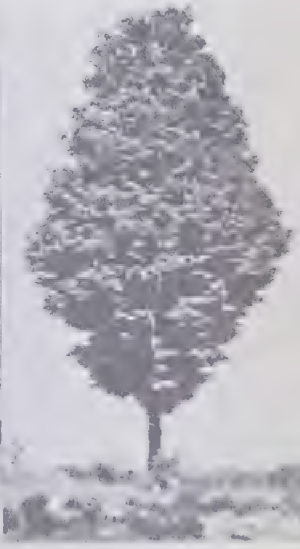
Oaks, maples, apple trees, elms, and birches are hardwoods. These trees have broad leaves which they shed every year. Hardwood trees have beautiful, spreading shapes. They bear flowers or blossoms.



Oak tree with Spanish moss

U.S. FOREST SERVICE

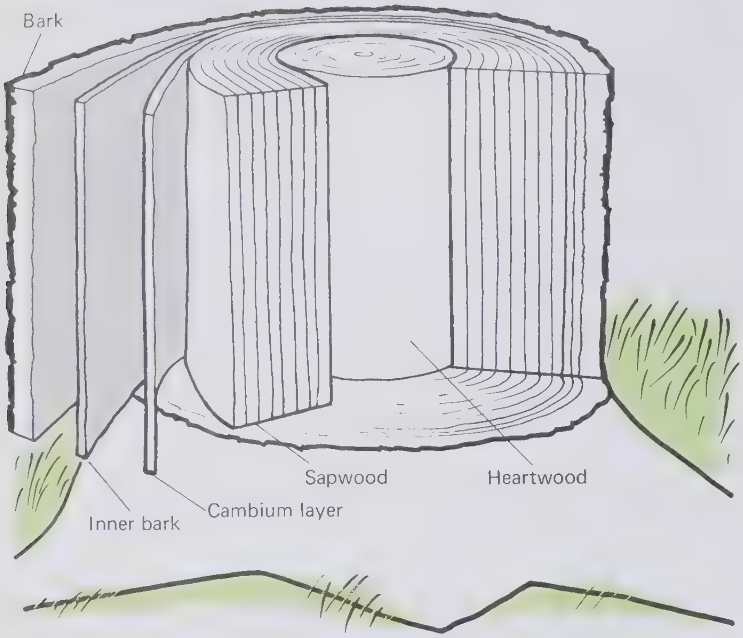
Apple



Maple

Hardwood is used for furniture. It is strong and often has a handsome grain.

3. Which type of tree do you see most often in your city?



C. TREE TRUNKS

A tree trunk has some surprises in it.

The outer, protective bark is made of dead cells. These dead cells wear off, just as the outer cells of your skin wear off.

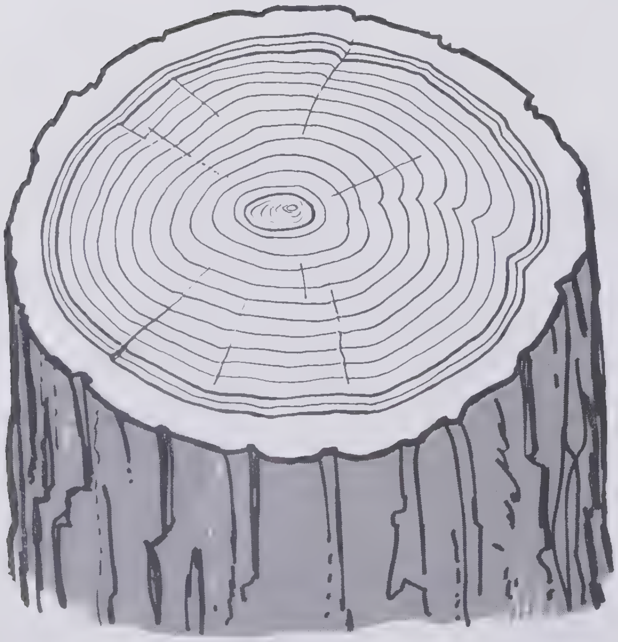
Inside the bark there is a thin inner bark. It is made of living cells which carry food from the leaves. As the inner bark cells die, they become part of the outer bark.

After the inner bark there is a growing layer called the **cambium.** Cambium cells are the only ones in the trunk that divide to make new cells. On the outer side the cambium makes inner bark cells. On the inner side it makes wood cells.

4. As the tree grows, how does the cambium make the trunk thicker?

D. SAPWOOD AND HEARTWOOD

Fresh, newly made wood cells are called sapwood. As the sapwood dies, its cell walls become heartwood. Most of the trunk is heartwood.

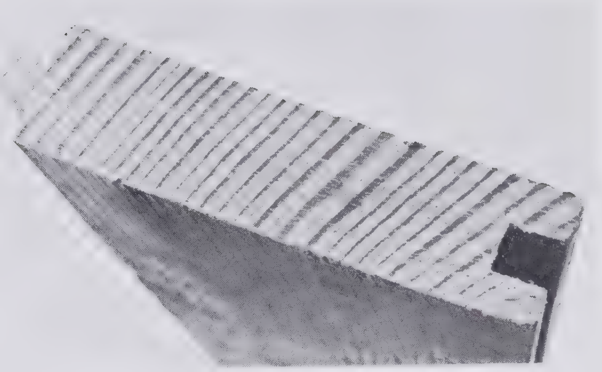


Every spring the active cambium makes large sapwood cells. Late in the summer the new cells that are made are smaller.

Because of this difference in size, each year's new wood shows up as an annual ring. A 10-year-old tree trunk will have 10 annual rings.

E. TREE PUZZLES

Lumber mills usually saw a log lengthwise into boards. This method makes the boards strong. It also shows the wood grain. The grain is the pattern made by long wood cells.



When you cut across a piece of wood, you don't see the grain. Instead you see a pattern made by annual rings, bark, branches growing out of the wood, and sometimes injuries and wormholes.

5. Can you use the pattern in wood to put together a tree puzzle?

TREE-PUZZLE ACTIVITY

A

Time yourself in putting together a tree puzzle.

B

Can others in the group beat you on the same puzzle?

C

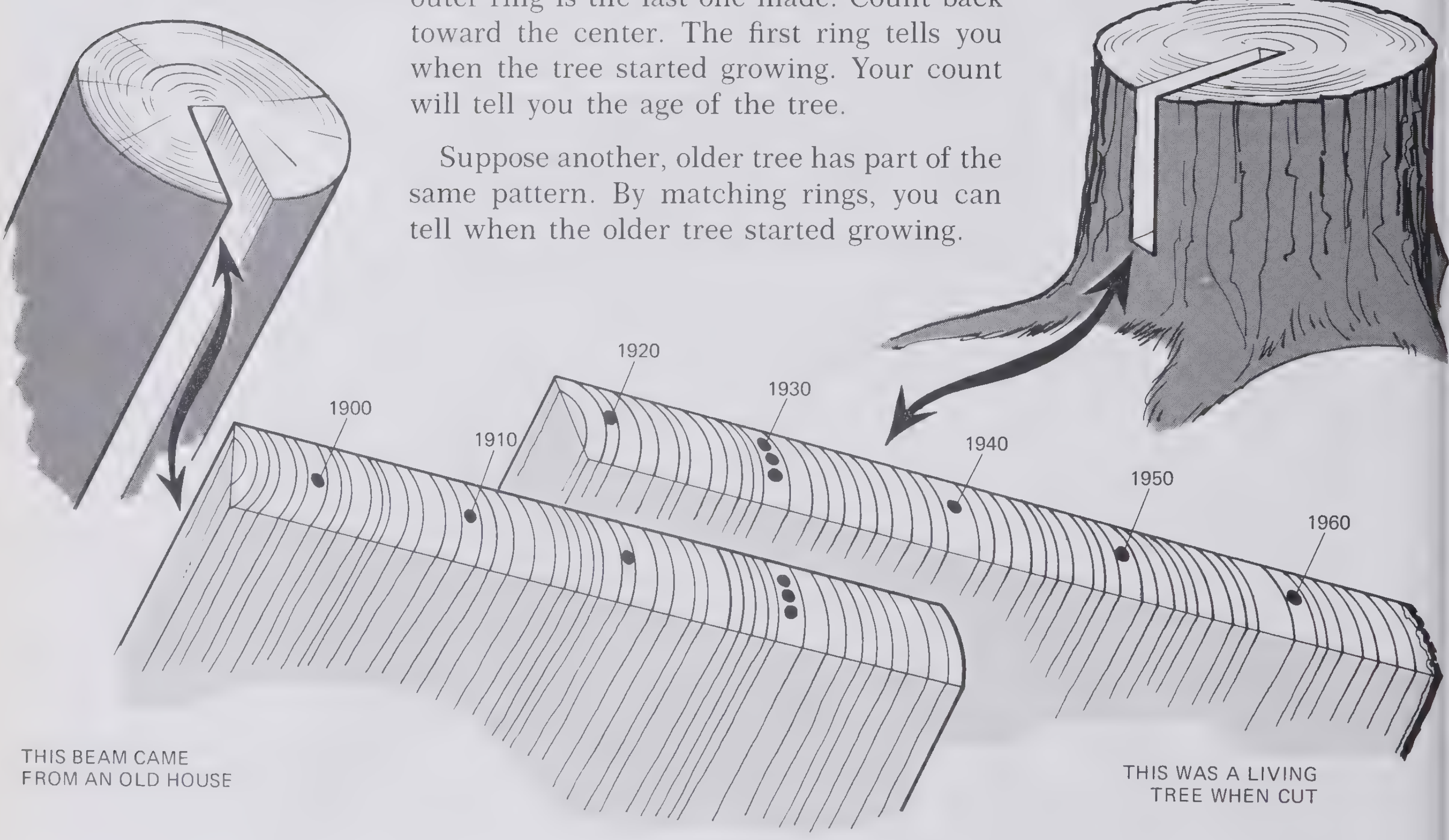
Cut a branch or a board into sections and make your own puzzle.

F. TREE CALENDARS

In a warm, wet year, a tree grows a lot. The annual ring is thick. In a dry, cold year, the annual ring is thinner. Tree ring patterns change with the climate. All trees in an area show the same pattern. Scientists who study old things can use this information to date wooden objects like boats and timbers of buildings.

Look at the annual rings in the figure. The outer ring is the last one made. Count back toward the center. The first ring tells you when the tree started growing. Your count will tell you the age of the tree.

Suppose another, older tree has part of the same pattern. By matching rings, you can tell when the older tree started growing.



THIS BEAM CAME FROM AN OLD HOUSE

THIS WAS A LIVING TREE WHEN CUT

6. From the beam, how can you tell when the house was built?
7. How do we know from tree rings that 1959 was a wet year?

G. JOBS INDOORS AND OUTDOORS

Wood and paper are 2 of our biggest industries. They provide hundreds of thousands of jobs at all levels of skill. Here are a few of the jobs:

- bookbinder
- cabinetmaker
- carpenter
- forest ranger
- forester
- lumberjack
- lumberyard salesperson
- paper box operator
- paper technologist
- papermaker

8. Look in the classified ad section of the newspaper. List all the jobs you can find that are connected with wood or paper.

6 ALL FOOD IS GREEN

word guide

acetone	*AS-uh-tohn*
photosynthesis	*foh-toh-SIN-thuh-sis*

The Bible says, "All flesh is grass." Science says, "All food is green."

Can you see why both are saying the same thing?

A. ALL FLESH IS GRASS

Think of some foods that come from plants. What would you say about bread, beans, spaghetti, tomatoes, chocolate, and margarine? Do all these food products come from plants, directly or indirectly?

Of course meat comes from animals. Milk, cheese, butter, eggs, and honey also come from animals. Bees, however, cannot make honey unless they have flowers for food.

INTERNATIONAL HARVESTER WORLD

B. A HOG IS A WALKING CORNFIELD

Farm animals feed on grass and corn. In a dry season the crops may fail. The farmer may have to kill the animals before they starve.

When this happens the prices of meat and dairy products go up. This is often a signal that supplies of animal foods are shrinking.

When crops are good, farm animals have plenty of food. They grow, and increase in number. Meat and dairy prices usually go down.

When we eat meat, we are really eating converted plants. Wild animals also depend on plants. That is why the Bible says all flesh is grass.

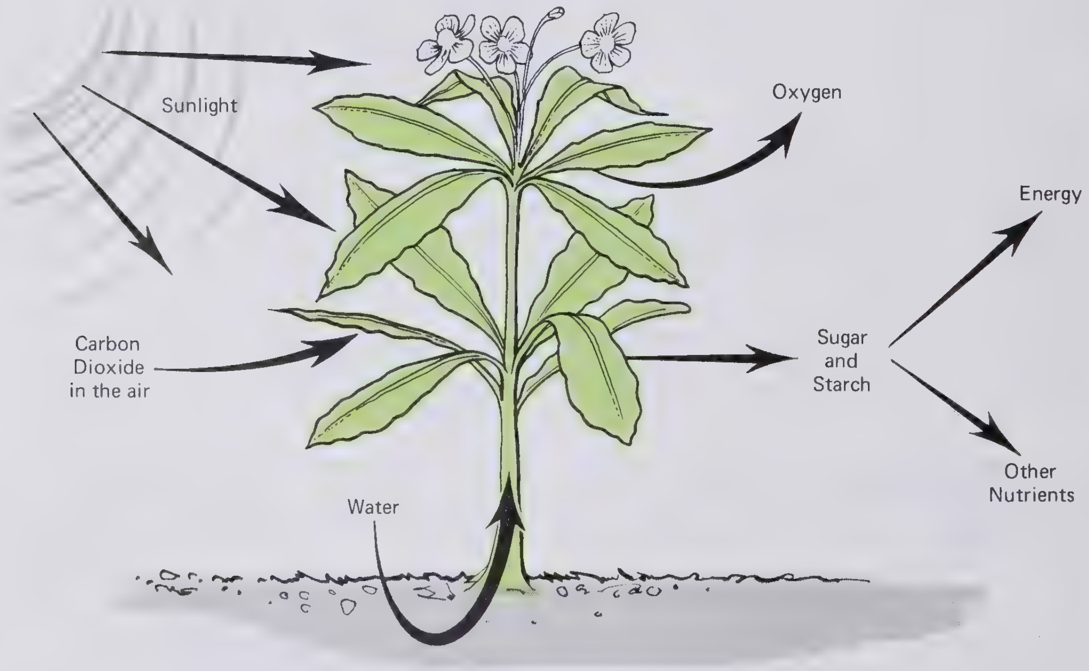
C. GREEN POWER

Plants are living things. They need food even though they don't eat as animals do.

Instead, green plants make their own food. They have the power to make food from air, water, and sunlight.

A green dye called chlorophyll gives plants this power. Notice how green the plant world is. Some small plants, like mushrooms and yeasts, are not green. These plants cannot make food for themselves. Instead they take in food made by green plants.

In green plants, chlorophyll in the leaves absorbs sunlight. It uses water from the soil and carbon dioxide from the air. It combines these materials into starch and sugar. These 2 carbohydrates store the sun's energy. This process is called **photosynthesis.**



D. GREEN MYSTERY

Plants make other nutrients by adding minerals to the carbohydrates. They get the minerals from the soil. In this way plants make all the foods on which life depends.

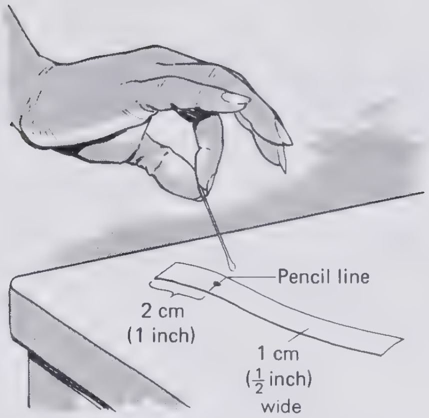
We do not fully know how chlorophyll does its mysterious work. We do know, however, what the green dye is made of. We can take it apart. We can watch it at work. You will do some of these things in the CHLOROPHYLL ACTIVITY.

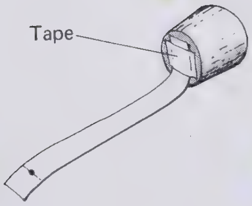
CHLOROPHYLL ACTIVITY

PART 1—SEPARATING INK

A

Place a tiny spot of ink on a filter paper strip.





B

Attach the paper to the bottom of a stopper.

C

Place a little water in a test tube. Hang the strip so that the ink spot is just above the water.

D

Watch the ink spot separate into several colors. You can separate chlorophyll in the same way.

PART II—SEPARATING CHLOROPHYLL

E

While watching the ink, grind some spinach leaves in a little **acetone.** (CAREFUL! ACETONE IS BOTH FLAMMABLE AND POISONOUS.)

F

With a thin glass tube or toothpick, place a tiny spot of chlorophyll solution on a fresh filter paper strip. Let it dry. Repeat until the spot is dark green.

G

Place 1 cm (½ inch) of developer in a test tube. Hang the chlorophyll strip just like the first one.

H

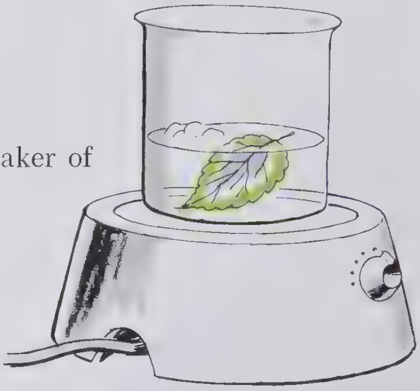
Watch the chlorophyll separate. Then remove the strip. Dry it and paste it in your notes.

1. How many different dyes did you get out of the chlorophyll?

PART III—CHLOROPHYLL AT WORK

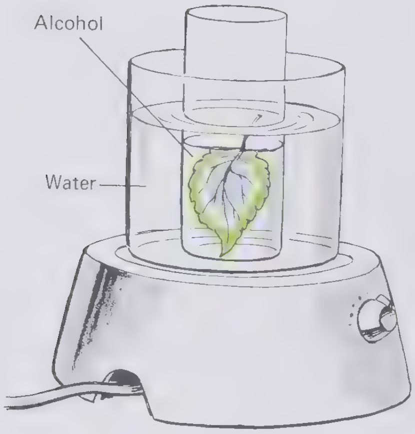
I

Take a many-colored leaf from a plant that has been standing in strong light. Notice which parts are green.



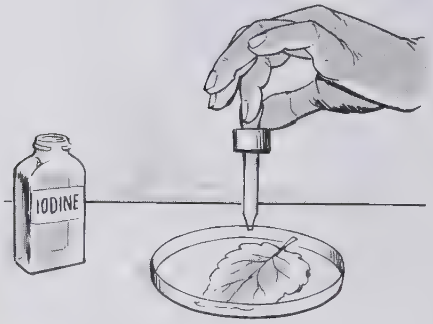
J

Soften leaf in beaker of hot water.



K

Soak leaf in hot alcohol to remove the color. (CAREFUL! HEAT ALCOHOL IN WATER BATH, NOT DIRECTLY ON BURNER.)



L

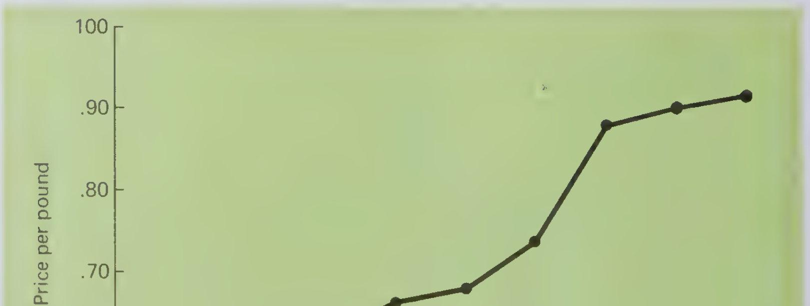
Use iodine to test leaf for starch.

2. Which part of the leaf has the starch?

3. What does "All flesh is grass" mean to you?
4. What foods can chlorophyll make?
5. What raw materials does chlorophyll use?
6. What is so great about chlorophyll?

7. Discuss the graph with your group. What factors do you think make meat prices go up and down?

AVERAGE ANNUAL RETAIL STORE
PRICE OF HAMBURGER
1966–1975



7 THE WATER ELEVATOR

We all want running water in our homes. Almost every big city is built on the banks of a river, a lake, or an ocean.

word guide

cobalt	*KOH-bawlt*
irrigation	*ir-i-GAY-shuhn*
seedling	*SEED-ling*
stomate	*STOH-mayt*
transpiration	*tran-spuh-RAY-shuhn*

COURTESY THE PORT AUTHORITY OF N.Y. & N.J.

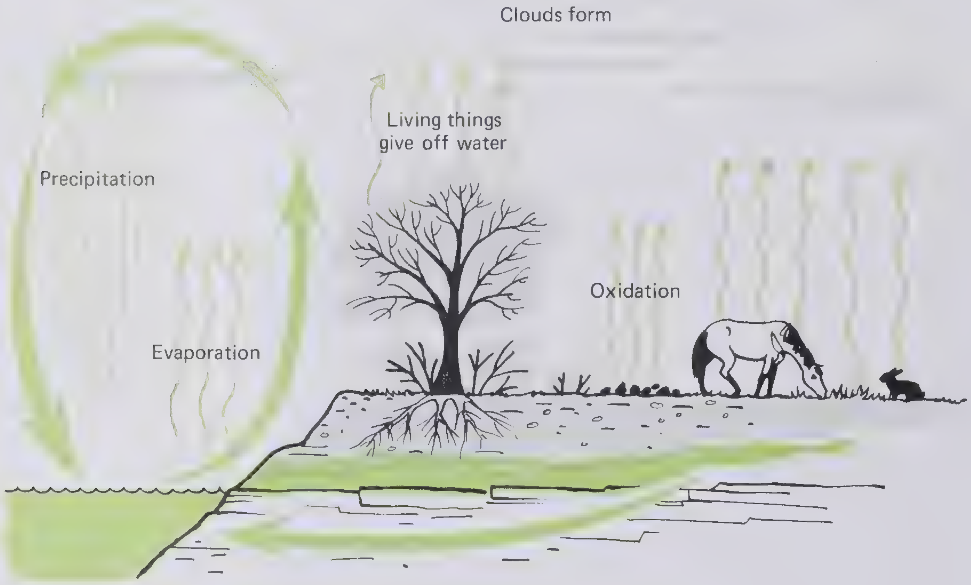
Most of the vegetables in the United States are raised in 3 great valleys in California. These valleys would be deserts except for **irrigation** water.

LAURENCE LOWRY AERIAL PHOTOGRAPHY

You can see that people need water. All living things must have water.

A. THE WATER CYCLE

The same water runs in our homes, flows past our cities, and irrigates growing plants in California. The same water, going round and round in the water cycle, is used everywhere.



Water falls as rain or snow. It waters plants and supplies thirsty animals. It runs over the land to reach the sea. It evaporates into the clouds and starts the cycle over again.

Living things, especially plants, fit into the water cycle.

WILSON, LOOMIS AND STEEVES—*BOTANY*, HOLT, RINEHART AND WINSTON, FIFTH EDITION

B. HOW TO WATER A PLANT

Everybody knows that plants need water. It doesn't do any good to water just the leaves of the plant. You have to water the roots. The roots take in the water.

Water taken in by the roots is used in the leaves. Suppose the roots don't get enough water. Then the leaves wilt.

U.S. FOREST SERVICE

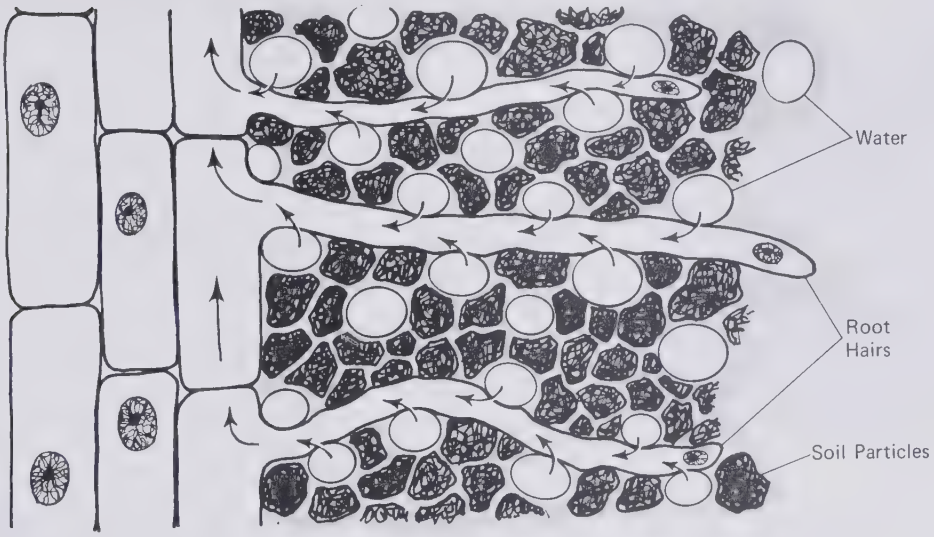
C. WHAT MAKES IT WORK?

The top leaves of a redwood tree may be 100 meters (300 feet) from the ground. The tree roots that take in water are deep in the earth.

The water rises through the trunk or stem, high in the air, to the leaves. How is it possible for the water to get that high?

In every plant stem there is a water elevator. It consists of tubes made of hollow wood cells. Three forces make the water elevator work. In the WATER-ELEVATOR ACTIVITY you can watch the 3 forces at work.

The first force is pulling. Roots pull in water from the soil.

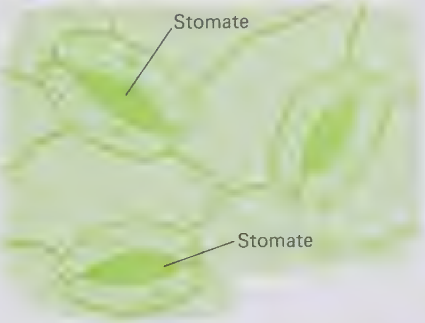


The second force is stickiness. Water sticks to the sides of the hollow wood cells. Each drop of water also sticks to the next drop.

D. THE LEAF HAS MOUTHS

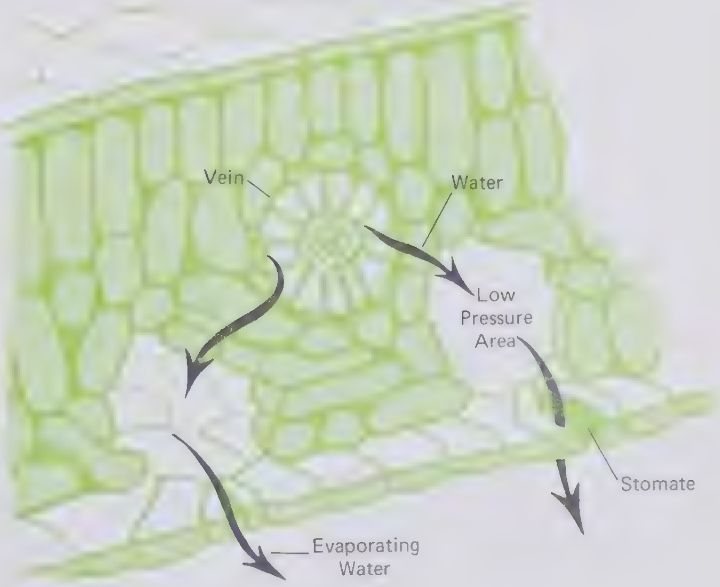
The third force is evaporation. This force is in the leaves. Let's see how it works.

In the skin on one side of a leaf there are tiny leaf mouths called **stomates.** Water from inside the leaf constantly evaporates through the stomates.



This loss of water leaves low pressure spaces within the leaf. The water in the stem flows upward into these low pressure spaces. It has reached the top of the water elevator. Some of it can now be made into food.

The evaporation of water from leaves is called **transpiration.** Leaves actually need only a small amount of water for food making. However, they transpire heavily in order to lift a small amount of water in the water elevator.



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E. PLANTS AND THE WATER CYCLE

Plants are part of the water cycle. They supply their leaves with water. The leaves turn part of the water into food.

Plants and people can change the water cycle. Thick forests slow it down. Trees and plants hold water in the ground and keep it from running off quickly.

Suppose the forests are cut down, and crops are planted instead. The water cycle speeds up. In one summer day, 4000 square meters (one acre) of grass can lose 5 metric tons of water through its stomates.

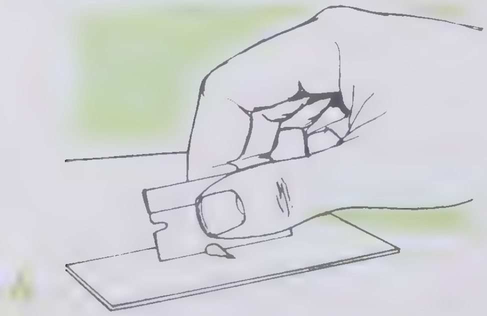
When we build roads and pave our streets, we also speed up the water cycle. The water can't soak into the ground. It runs off quickly.

People are using more and more water. However, the use of water does not speed up the water cycle to produce more pure water. Can you see why shortages of clean water may be a growing problem in our country?

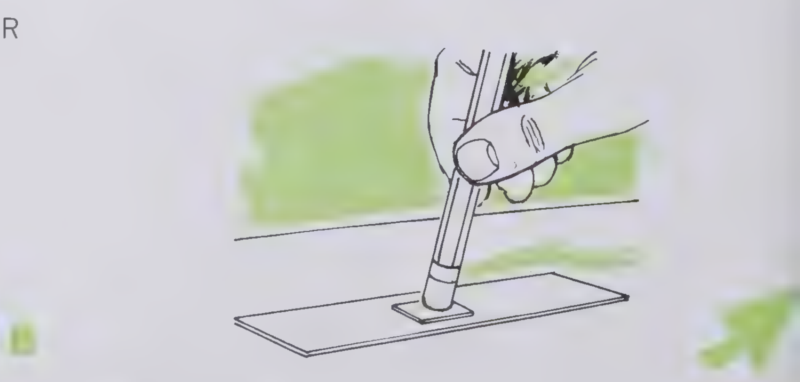
1. What is the water elevator in a plant?
2. What 3 forces keep the water elevator going?
3. What do we mean when we say that plants transpire?
4. How do plants slow down the water cycle? How do they speed it up?
5. How do people affect the water cycle?
6. Has your community been hit by water shortages? Explain them.

WATER-ELEVATOR ACTIVITY

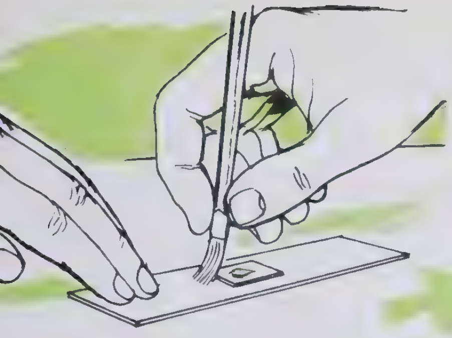
PART I—WHERE THE ROOT TAKES IN WATER



Place grass **seedling** in drop of salt water. Cut off the root.



Remove seedling. Place cover slip over root. Press cover slip to flatten root.

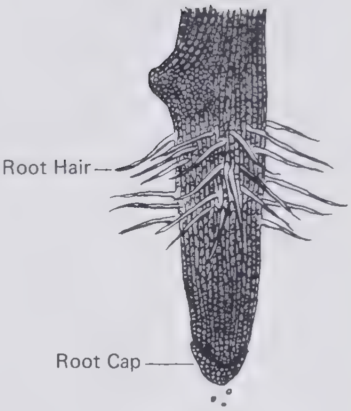


C

Seal slide with wax.

D

Examine root under microscope. Note root cap covering growing tip. Farther back, note root hairs growing out of root. Root hairs take in water.



E

Watch root hairs patiently.
7. Can you see them growing?

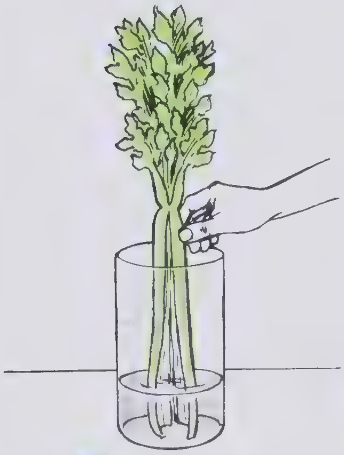
PART II—WATER RISES IN THE STEM

F

A celery stalk is a stem. Split stem part way up.

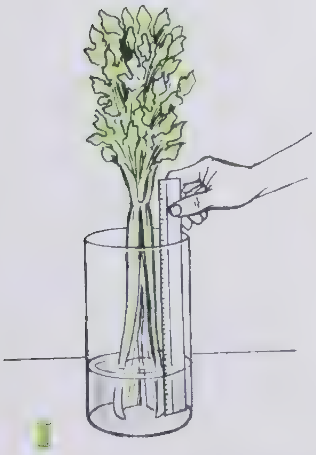
G

Trim bottom of stem evenly, under water. Don't let cut end dry out.



H

Quickly dip in dye solution.



I

Every 3 minutes, examine the split. Measure how high dye has risen.

RISE OF DYE IN CELERY STEM

Time from Start	Height of Dye

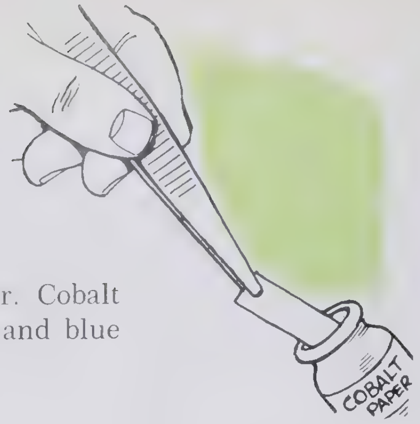
J

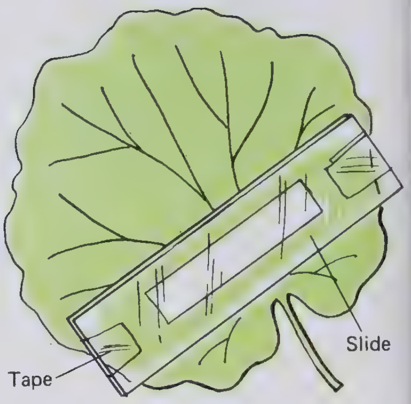
In your notes keep a record like this.
8. How fast did the dye rise in the stem?

PART III—COBALT PAPER

K

Cobalt paper detects water. Cobalt paper is pink when damp, and blue when dry. Take 2 strips.





L

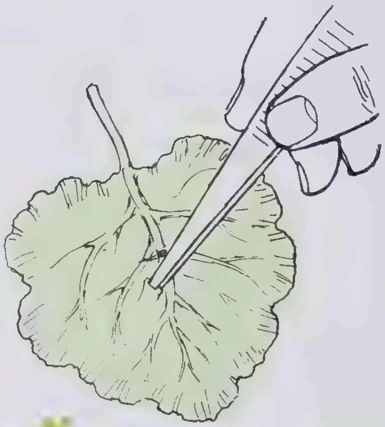
Press a strip of cobalt paper against each side of a leaf.

9. Which side of the leaf turns the paper pink first?

PART IV—STOMATE SLIDE

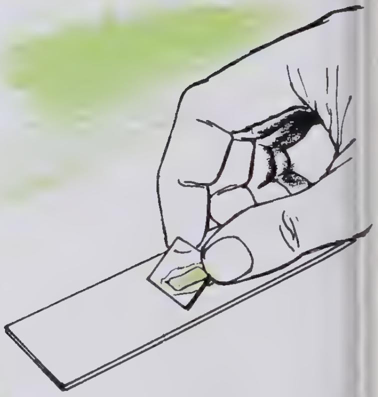
M

Crack a leaf.



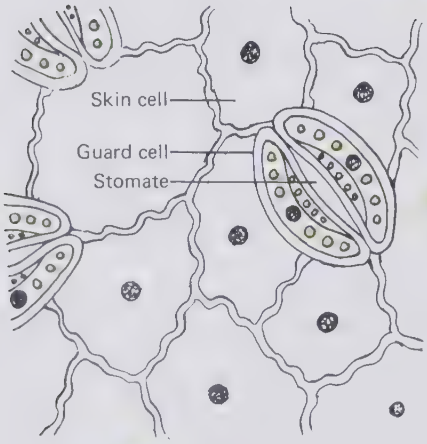
N

Peel skin off underside.



O

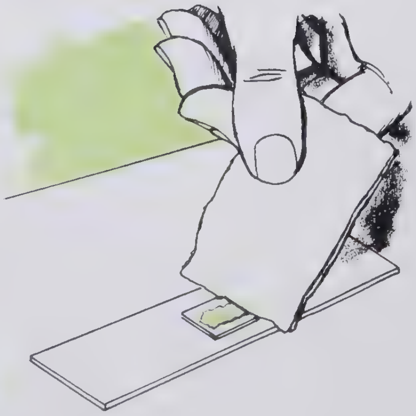
Mount skin flat, in water, and add a cover slip.



P

Find the stomates. Notice guard cells, like lips around each stomate.

10. Are the stomates open or closed?



Q

Add salt water to slide. Use paper towelling to draw it under cover slip. Salt changes the guard cells.

R

Again examine stomates and guard cells.

11. How do guard cells control evaporation from the leaf?

8

FOOD AND GAS AVAILABLE

A spaceship cannot blast through space indefinitely. If it does, the men inside will run out of air to breathe and food to eat.

The earth is like a great spaceship. There is evidence that life has been on earth for at least 3 billion years.

word guide

atmosphere	*AT-muhs-feer*
phenol	*FEE-nohl*

A. SPACESHIP EARTH

No supplies ever leave the earth. No new supplies come on board except sunlight. The supplies that we now have must last forever.

Why don't we use up our air and food?

You know that green plants are part of the answer.

Green plants make their own food.

Green plants provide food for human beings and animals.

It certainly is!
Beautiful planet!

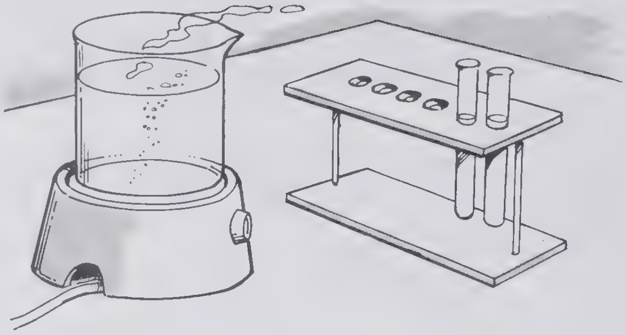
B. PHOTO . . . WHAT?

The food-making process in plants is called photosynthesis. This long word means "manufacture with the help of light." This word is used because when green plants manufacture food, they have the help of sunlight.

You already know many details about photosynthesis. You know that in making food, plants use sunlight, water, and carbon dioxide (also called CO_2). You also know that a plant makes 2 basic foods, sugar and starch. These foods are carbohydrates.

It took a century of experiments by many scientists to collect the knowledge that we have just summarized. In the GAS ACTIVITY you can get an "instant replay" of some of these experiments.

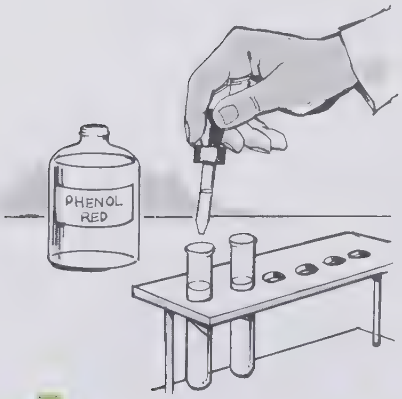
GAS ACTIVITY



EXPERIMENT I

A

Boil some water to drive out the carbon dioxide (CO_2) gas. Fill 2 test tubes nearly full of the water.



B

Add enough **phenol** red to color the water.

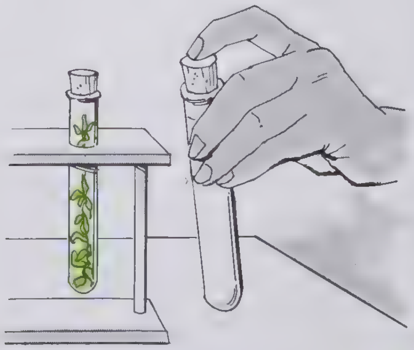
C

With a straw, slowly blow into the solution in the test tubes. The CO_2 in your breath will produce a change.

1. How do you know when there is CO_2 present? When there is no CO_2?

D

Add a water plant to one tube.



E

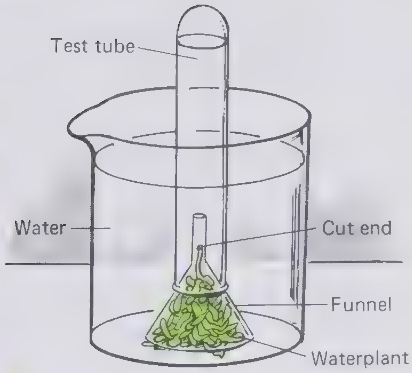
Stopper both tubes. Place them under a lamp for 10 minutes.

2. What change takes place? How do you explain the change?

EXPERIMENT II

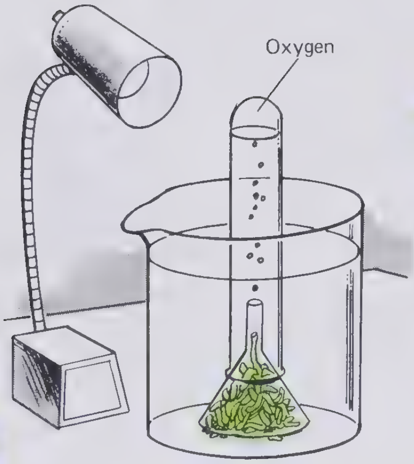
F

Cut the stem of a water plant.



G

Arrange plant like this, cut end up.



H

Place set-up under a lamp. Watch for bubbles of gas.

I

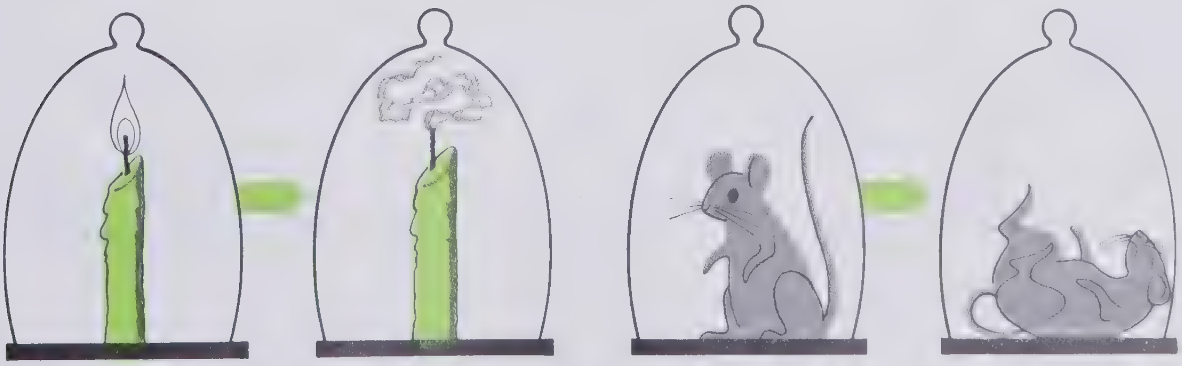
When enough gas collects, use glowing splint to test for oxygen. If oxygen is present, splint will burst into flame.

3. Where did the oxygen come from?

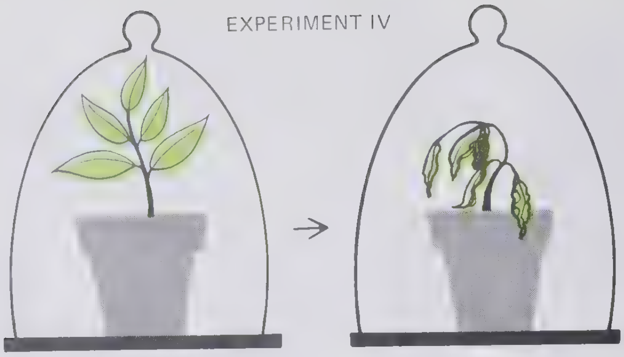
C. THE MOUSE AND ITS BUDDY

Here are several more experiments. These were first done in England about 200 years ago by Joseph Priestley. Priestley later came to America.

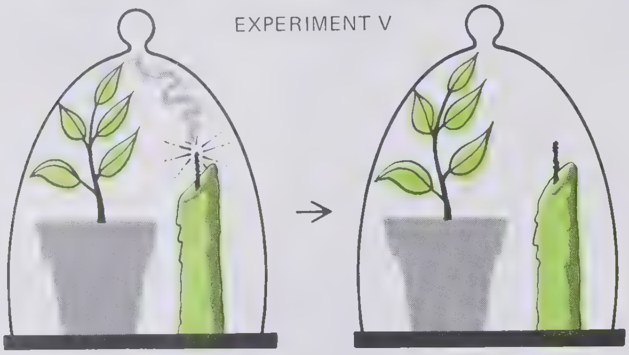
EXPERIMENT III



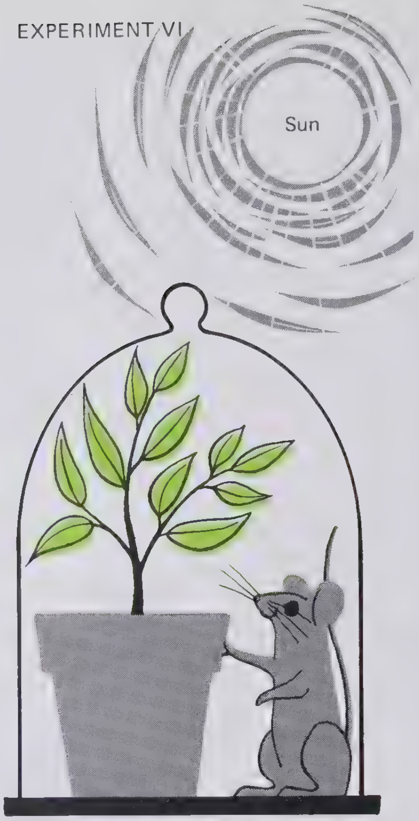
EXPERIMENT IV



EXPERIMENT V



EXPERIMENT VI



4. In Experiment III, what 2 things happened?
5. How can you explain them?
6. In Experiment IV, what happened to the plant?
7. How do you explain this result?
8. Why are the plants different in Experiments IV and V?
9. In Experiment VI, why did both the mouse and the plant stay alive?

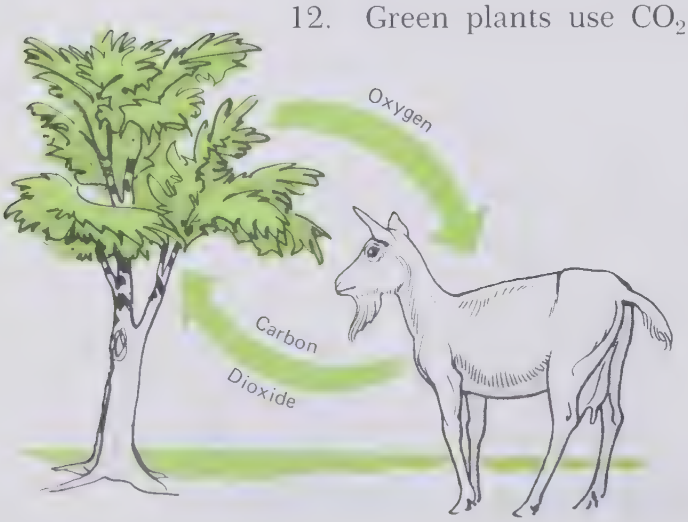
D. GAS EXCHANGE

We live surrounded by the **atmosphere.** This is an ocean of air. We exchange gases with the air. We breathe in and use oxygen. All animals do the same. In return, animals breathe out CO_2.

Green plants also exchange gases with the air. However, the exchange is opposite to that of animals. Green plants take in and use CO_2. They give out oxygen.

Which of the "instant replay" experiments show that:

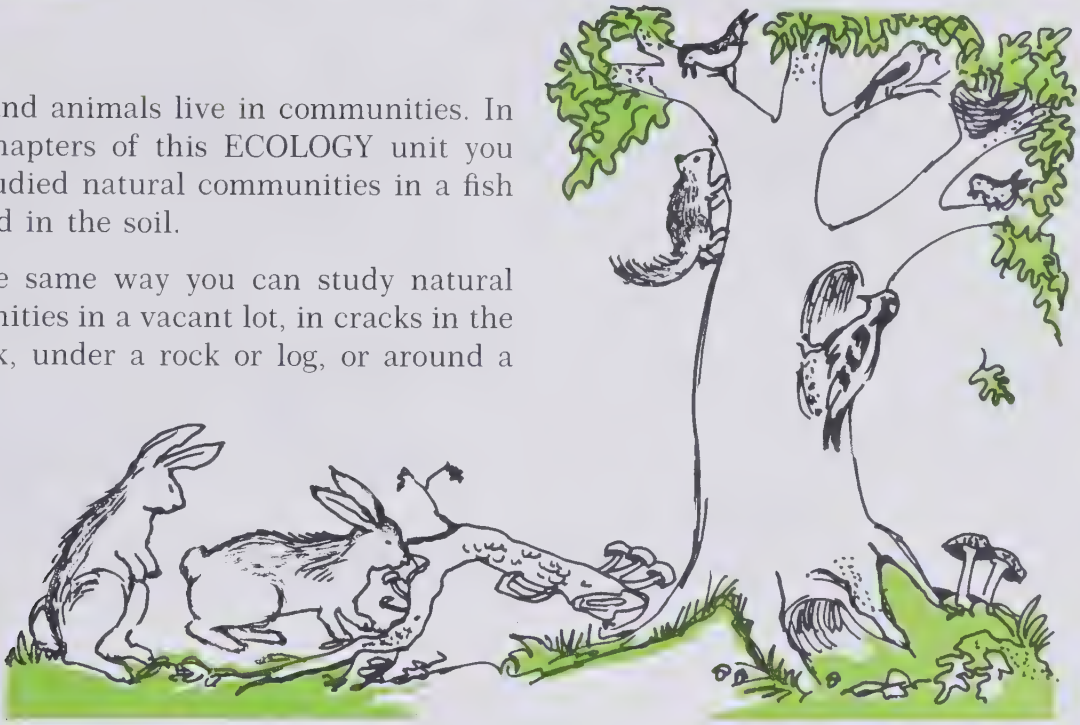
10. Animals use oxygen?
11. Animals give out CO_2?
12. Green plants use CO_2?
13. Green plants give out oxygen?



Through the atmosphere, animals and green plants exchange gases with each other. We get oxygen from green plants. The plants get CO_2 from us.

Therefore, green plants not only provide us with food. They also provide us with the air we breathe. Our buddy the green plant!

9 TO LIVE IS TO BELONG



Plants and animals live in communities. In other chapters of this ECOLOGY unit you have studied natural communities in a fish tank and in the soil.

In the same way you can study natural communities in a vacant lot, in cracks in the sidewalk, under a rock or log, or around a tree.

A. A COMMUNITY IS LIVING THINGS

A community is more than a place to live. Mainly it is a group of living things that are linked to each other.

The links that tie a natural community together are the various ways of getting food. You know three ways for living things to get food:

Green plants make their own food. They are called producers.

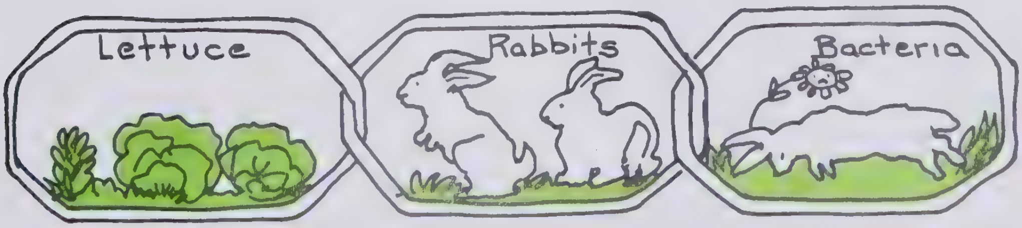
Animals depend on food made by green plants. They are called consumers.

Microbes consume dead material. They are called decomposers.

In a natural community, the producers, consumers, and decomposers are linked together in food chains.

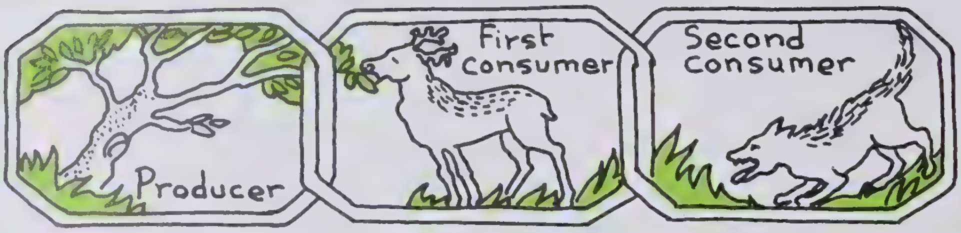
B. FOOD CHAINS AND FOOD WEBS

Here is a food chain.



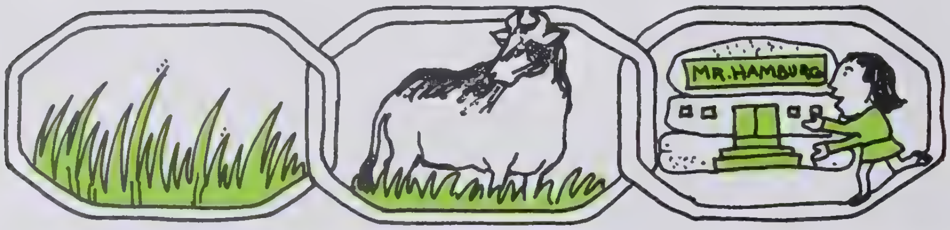
1. Name the producers, the consumers, the decomposers.
2. Why must every food chain start with a producer?

Here is another food chain.



3. Why is the deer called a first consumer and the wolf a second consumer?

And here is still another food chain.

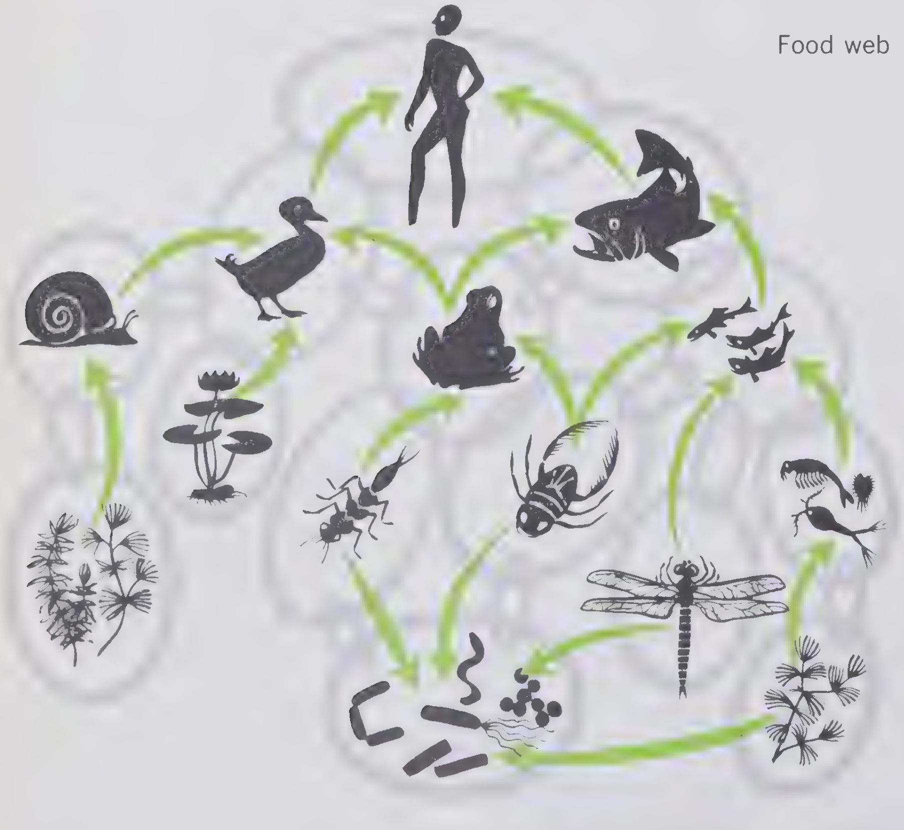


4. What link is the girl in the food chain?

You will see more food chains in the ECOLOGY RUMMY GAME.

A real living community is never this simple. The various food chains are all tied together to make a complex food web.

Food web



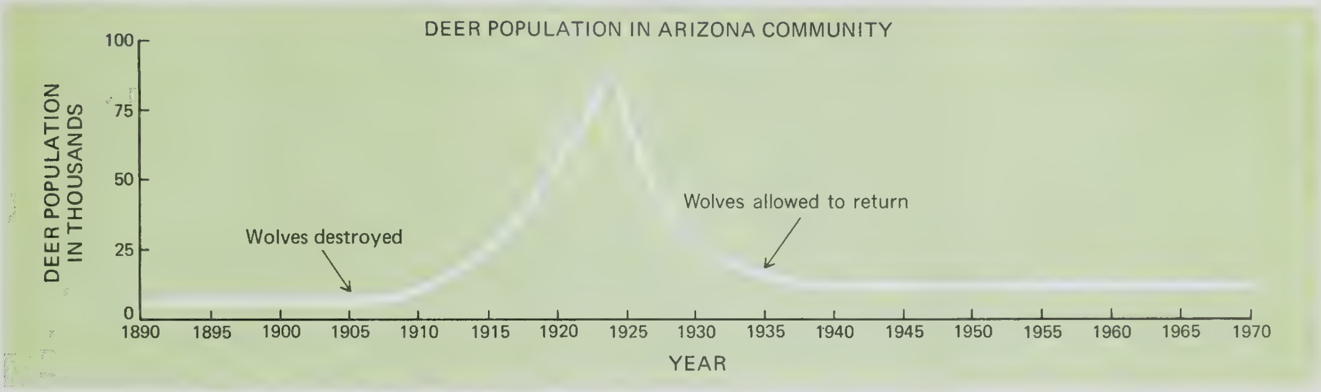
C. KEEPING THE BALANCE

In nature, every creature seems to be food for some other creature. This isn't as terrible as it may sound. All living creatures benefit from belonging to communities and food webs.

For example, wolves feed on deer. The wolves hunt mainly the young, the old, the sick, and the weak. Strong, healthy deer usually escape.

Suppose all the wolves were killed. Then too many deer would survive. They would eat all the plants in the community. Many deer would then starve.

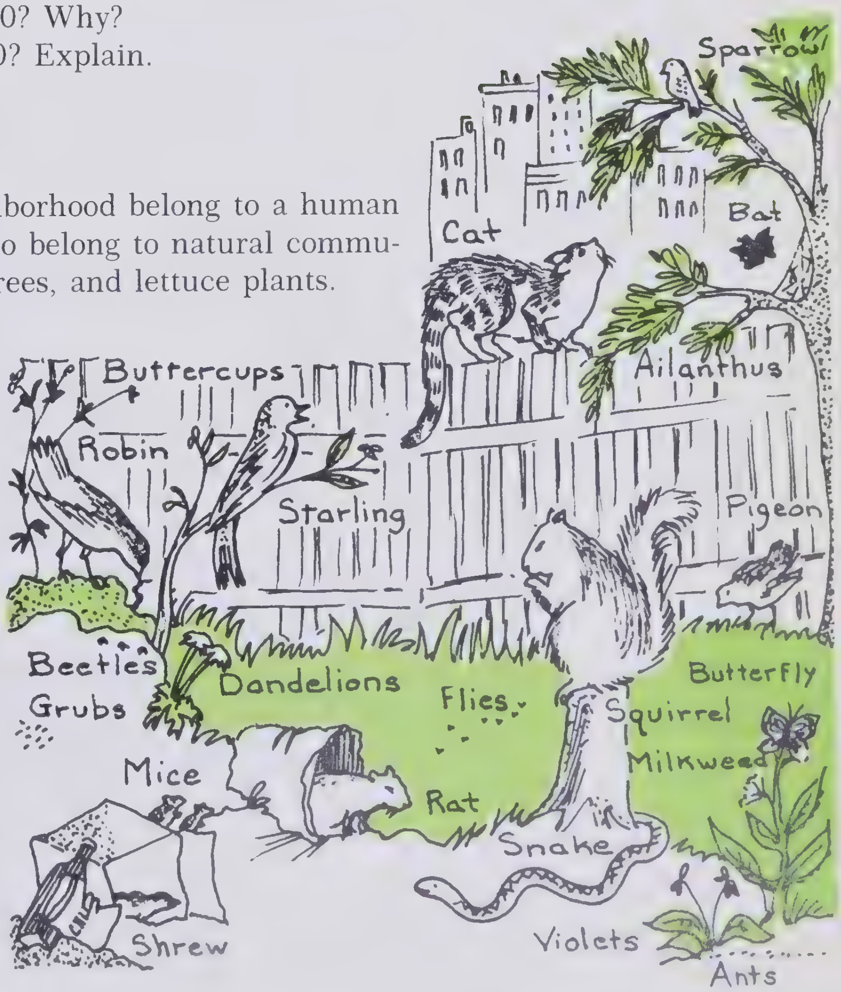
This happened once in a community in Arizona near the Grand Canyon. The dying deer herd was restored to health when wolves were allowed back in the community. The graph shows changes in the Arizona deer population during this period.



5. What was the deer population in 1924? Explain the large population.
6. What was happening to the deer in 1930? Why?
7. What happened between 1940 and 1970? Explain.

D. EVERYTHING IS CONNECTED

You and the other people in your neighborhood belong to a human or social community. Human beings also belong to natural communities, along with deer, wolves, cows, trees, and lettuce plants.



Take any city community. The animals in it include dogs, cats, bats, rats, and mice. The community also contains sparrows, pigeons, gulls, and starlings. You can also find flies, ants, mosquitoes, and cockroaches in the community.

Plants in the city community include trees, shrubs, and grasses. And weeds are found in vacant lots and sidewalk cracks.

Because people also belong to this community, the food web is larger than the community itself. The city's food web covers the entire world. Grain comes from the West, meat from Argentina, vegetables from Texas and California, potatoes from Idaho and Maine, and cocoa from Africa.

8. Explain how mice and mosquitoes in Chicago get their food from Argentina and Maine.

You now know that we belong to the same communities and food webs as do the animals and plants that live with us. In the long run we all live or die together.

ECOLOGY RUMMY

1. Use a deck of 52 cards marked as follows:
   - 19 water-air-soil-sun (WASS) cards
   - 8 green plant producer cards
   - 6 plant consumer cards
   - 3 meat consumer cards
   - 8 decomposer cards
   - 8 polluter cards
2. Two or 3 may play.
3. Choose for dealer. Mix the cards.
4. Deal 8 cards to each player. Turn up one card. Place the rest of the deck face down.
5. Starting at the dealer's left, each player in turn draws a card. The player may draw the top card from the deck, or the top face-up card. The player discards one card face up.
6. Each player tries to make chains as follows:
   - WASS—producer—decomposer
   - WASS—producer—plant consumer
   - WASS—producer—plant consumer—decomposer
   - WASS—producer—plant consumer—meat consumer
   - WASS—producer—plant consumer—meat consumer—decomposer
7. A 3-card chain counts 5 points. A 4-card chain counts 10 points. A 5-card chain counts 20 points.
8. The object of the game is to knock with rummy by making chains. A player may knock with 8 or 9 cards, including the discard.
9. After a player has knocked, if the opposing player(s) can place 2 polluter cards on a chain, that chain does not score.
10. Others check the hand. If the player knocked correctly, add up the points. Do not count the points for any chain that has 2 polluter cards on it. A player who did not have the right to knock picks up the cards, and the game continues.
11. If the deck is used up and no player has knocked, turn over the face-up pack and continue.
12. The winner is the player with the most points when the game is called.

10 ONE THIRD OF A NATION

People normally do not live alone on desert islands. They live together in human or social communities.

A human community may be a small town and its surrounding farms. It may be a small section of a city. It may be a **suburb** just outside a large city.

There are over 210 million people in the United States. About one third live in each of these 3 types of communities.

word guide

environment	*en-VY-ruhn-muhnt*
industrial	*in-DUS-tree-uhl*
museum	*myoo-ZEE-uhm*
professional	*pruh-FESH-uhn-uhl*
specialized	*SPESH-uh-lyzd*
suburb	*SUB-uhrb*
transportation	*trans-puhr-TAY-shuhn*

A. YOUR NEIGHBORHOOD

Suppose your turf is a few blocks in a large city. Your family belong to this community. Your friends, neighbors, and the kids who go to the local school also belong to the community.

So do those who staff the school, the library, the park, the businesses, and the police station. Each person has his or her place in the community.

You have some connection with everybody in the community. This doesn't mean that you know everybody. But you do know somebody who knows somebody who knows somebody. Links such as this tie the community together.

1. List, or show in a diagram, 8 kinds of people in your community with whom you have links. What is your connection with each?

B. THE SUPERCOMMUNITY

Your community doesn't live by itself, any more than you live by yourself. For example, many people must travel out of the neighborhood to go to work.

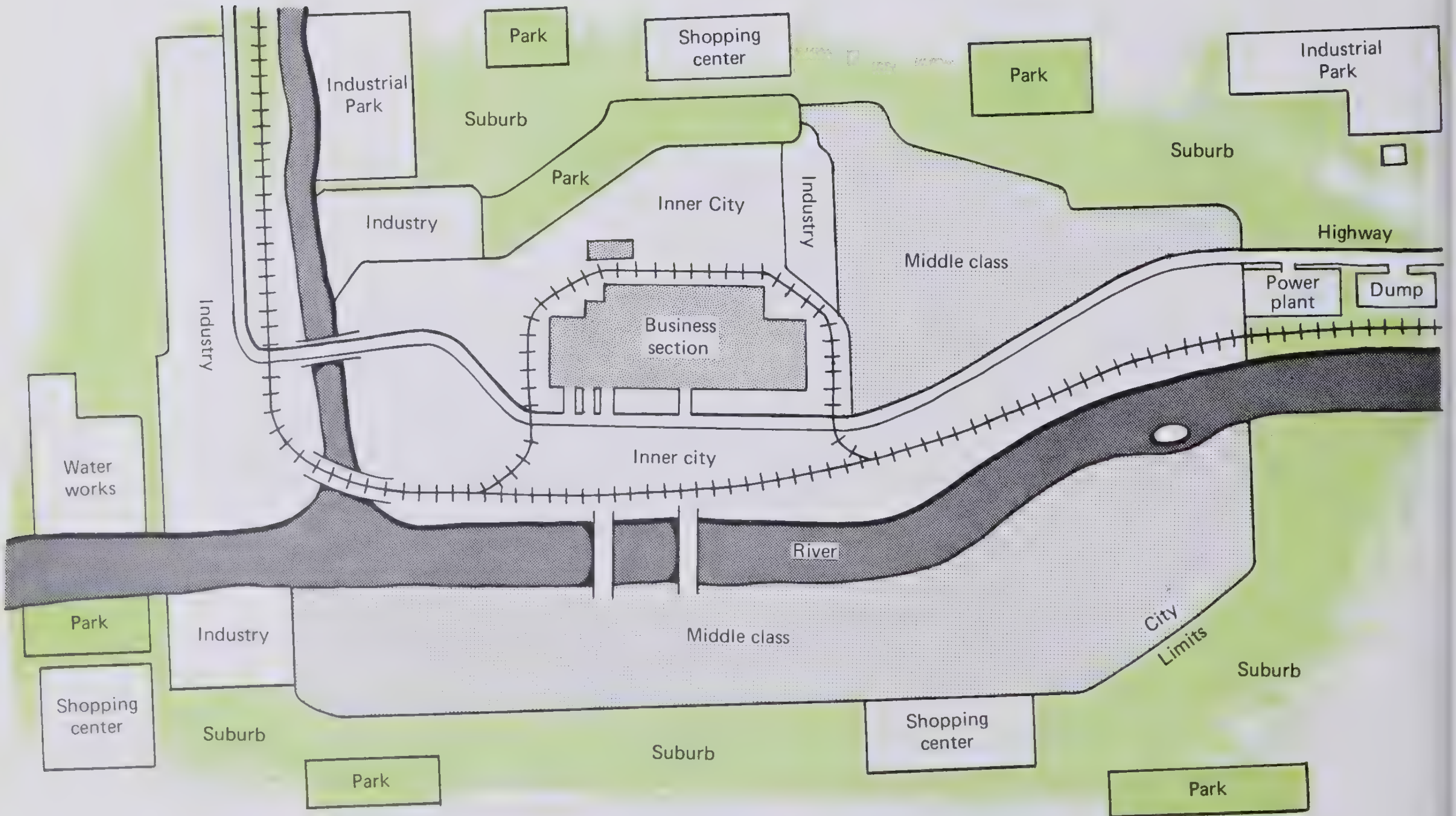
The airport and the railroad station probably are not in the neighborhood. You have to leave the neighborhood to visit a **professional** ball park, a live theatre, a **museum,** or a department store. City hall, and certain business and government offices are probably not located in the neighborhood.

There is a reason for this. A big city is made of many **specialized** districts. The districts are tied together to make a kind of supercommunity.

C. CITY GEOGRAPHY

Some people never leave their neighborhoods. They miss a lot, because they never get to know the whole city.

Yet it is so easy to get to know your way around. Most American cities are built on the same plan.



Downtown is the center of the city. The tallest buildings and the most crowded streets are located here. Department stores, theatres, and big offices are here also. Land in the downtown area is expensive.

Around the downtown area are inner city neighborhoods. The houses are old and crowded. The stores are small. Many of the people are poor.

Factories are clustered in **industrial** districts, always near the railroad or highway, or along the river.

2. Why do many people never leave their neighborhoods?
3. Why are factories always located near good **transportation?**

D. SUBURB AND INNER CITY

People with more money tend to live farther out in newer neighborhoods that have many private houses. Some of these neighborhoods are suburbs. They are tied to the city, but are not part of it.

People within a neighborhood are in touch with each other. But often the inner city and the suburbs are out of touch. Many problems of American cities spring from this separation.

W. B. FINCH

4. This chapter describes a typical American city. Does the description fit your city?

Suburb and inner city communities are somewhat different environments. The **environment** is everything that surrounds and affects living things.

Your environment includes the air, land, buildings, people, animals, and plants around you. By traveling around, you can study different city environments.

The ENVIRONMENT WORKSHEET is a guide for this kind of study. First use the WORKSHEET as a guide to describe the environment around your school. You can use a second copy to describe some other environment in the community.

ENVIRONMENT WORKSHEET

THE NEIGHBORHOOD

Businesses

______ offices
______ stores
______ factories
______ other (describe)

Public Buildings

______ library
______ church
______ health center
______ police or fire station
______ other (describe)

______ signs and billboards
______ markings on buildings
______ empty lots
______ damage to buildings
______ trash or litter (describe)

BUILDING MATERIALS OF THE CITY

Location or Use

______ brick or tile
______ stone
______ cement, concrete, stucco
______ wood
______ metal
______ glass
______ tar or blacktop
______ paint

TRAFFIC

Stand in one spot for 5 minutes. Make a count of each of the following that you see:

______ people
______ cars
______ trucks
______ other (airplanes, motorcycles, horses, etc. —describe)

SOIL

Look at the bare ground nearest the school building. Describe it.

Take the temperature
_____ 5 cm (2 inches) above ground _____ at the surface _____ 5 cm (2 inches) below ground.

Pour some water on the ground. Does the water sink in
______ quickly ______ slowly ______ not at all?

ANIMALS

Mammals

______ dogs
______ cats
______ squirrels
______ rats or mice
______ other (name)

Birds

______ sparrows
______ starlings
______ pigeons
______ gulls
______ robins
______ other (name)

Invertebrates

______ ants
______ caterpillars
______ roaches
______ flies
______ moths or butterflies
______ beetles
______ spiders
______ worms
______ other (name)

Animal Signs

______ droppings
______ feathers
______ nests
______ paw prints
______ other (describe)

PLANTS

Kinds of Plants

______ trees
______ shrubs
______ grass and herbs
______ mosses

Where Plants Grow

______ on the lawn
______ close to building
______ in sidewalk cracks
______ near the curb
______ around poles
______ in vacant lots
______ in the park
______ in people's yards
______ in window boxes
______ other (name)

11 THE CITY IS SICK

Middletown is in trouble.

Although the suburbs around the city are growing, people are moving out of Middletown itself.

word guide

employees	*em-ploi-EEZ*
integration	*in-tuh-GRAY-shuhn*
proposals	*pruh-POH-zulz*
renewal	*ri-NOO-uhl*
urban	*UHR-buhn*

A. THE PROBLEM

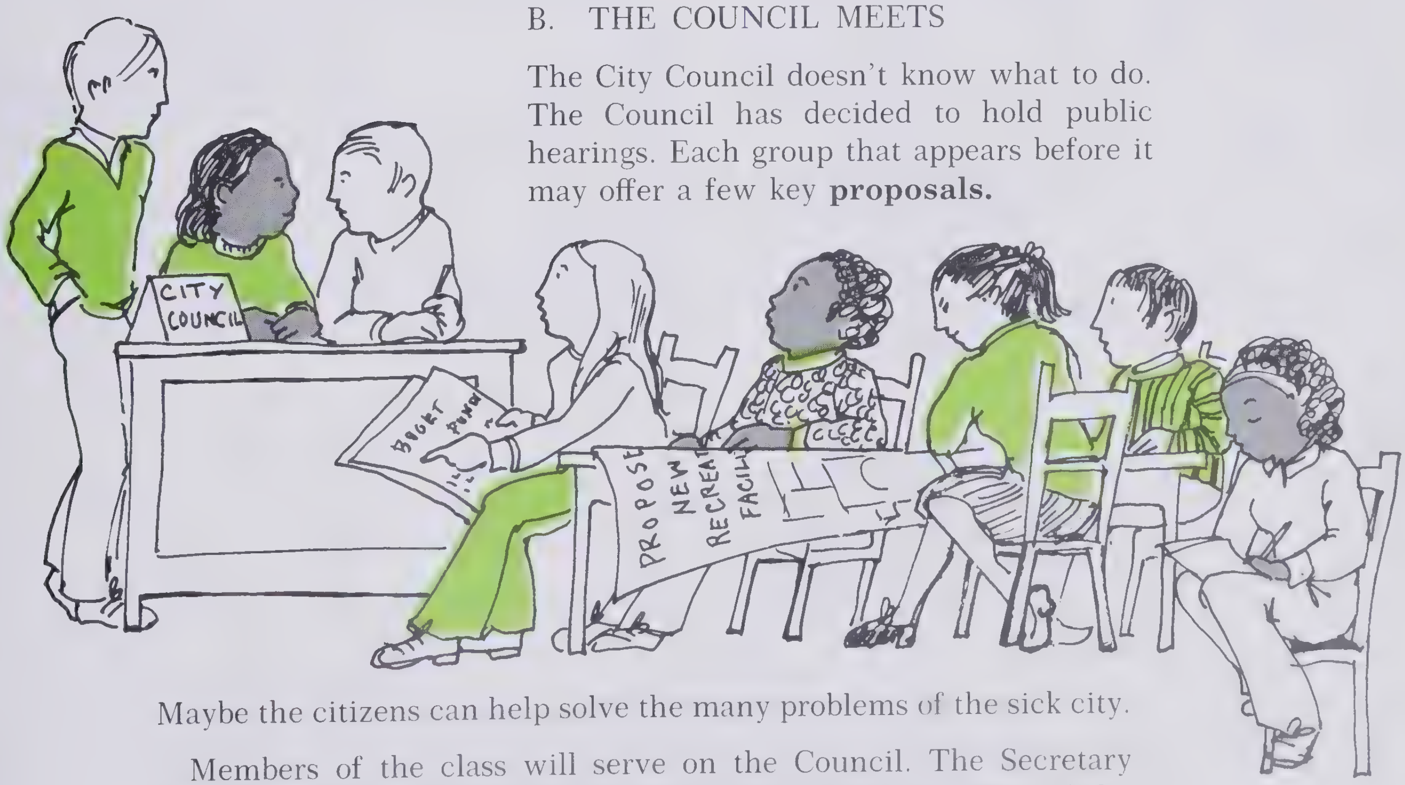
City **employees** have just gone back to work after a long strike. They wanted more money. They won a small raise.

A recent electric power failure blacked out the city for 24 hours.

People say taxes are too high. The crime rate is too high. Housing is bad. Traffic is bad. The air is bad. The parks are dirty and unsafe.

B. THE COUNCIL MEETS

The City Council doesn't know what to do. The Council has decided to hold public hearings. Each group that appears before it may offer a few key **proposals.**



Maybe the citizens can help solve the many problems of the sick city.

Members of the class will serve on the Council. The Secretary should keep a record of the proposals that are offered. After all the proposals are in, the Council will discuss and vote on them.

Others in the class may volunteer for the 4 groups that have asked to be heard. Your group can offer its own proposals. It can also discuss the proposals of other groups. Here are the 4 groups.

TENANTS' LEAGUE

The houses we live in are crummy and the rents are high. Landlords should be made to keep up their buildings. Get rid of the lead paint that poisons our children. Get rid of the rats and roaches.

Urban renewal is supposed to give us better housing. We need more of these projects.

We need better police protection, too. We are tired of muggings and burglaries.

MERCHANTS' ASSOCIATION

Our members are storekeepers. Business used to be good in Middletown. Now many of us are thinking of moving our stores out of the city to suburban shopping centers.

We are tired of being robbed. We are tired of losing customers because of traffic jams and dirty streets.

PARENTS AND CITIZENS FOR **INTEGRATION**

One of our basic problems is that whites, especially those with money, are moving out to the suburbs. The blacks and the poor are left behind in the inner city. The city has all the problems and little tax money. The suburbs have plenty of money, and fewer problems.

All the schools should be integrated. Some suburban kids should come into the city. Some city kids should go to schools in the suburbs. Then we would all have to face our common problems together.

ECOLOGY SOCIETY

People live in a community, just as plants and animals do. If the community isn't livable, the people will move out. We must make our city livable again. How can we do this?

Plant trees on every street. Trees give beauty and shade. Build playgrounds and swimming pools for the kids.

Clean up air pollution. Do not allow power plants in the city. They foul the air.

12

WATER, WATER EVERYWHERE

New York City's **reservoirs** are low. The mayor appeals to everybody to use less water.

On Long Island, the oily taste and smell of well water makes people hold their noses.

Millions of fish die in the **polluted** waters of the Mississippi River.

Farmers in California's Imperial Valley draw irrigation water from the ground. They draw out fresh water faster than nature can replace it. Salty ocean water seeps in under the Valley.

1. What nationwide problem do these 4 examples deal with?

word guide

detergent	*di-TUHR-juhnt*
ferment	*fer-MENT*
oxidized	*OK-suh-dyzd*
polluted	*puh-LOOT-id*
reservoirs	*REZ-uhr-vwahrz*

U.S. BUREAU OF SPORT FISHERIES AND WILDLIFE

Fish kill in polluted water

STATE OF CALIFORNIA

Irrigation

A. WHY WE NEED WATER

You know that plants must have water. Animals and people need it too.

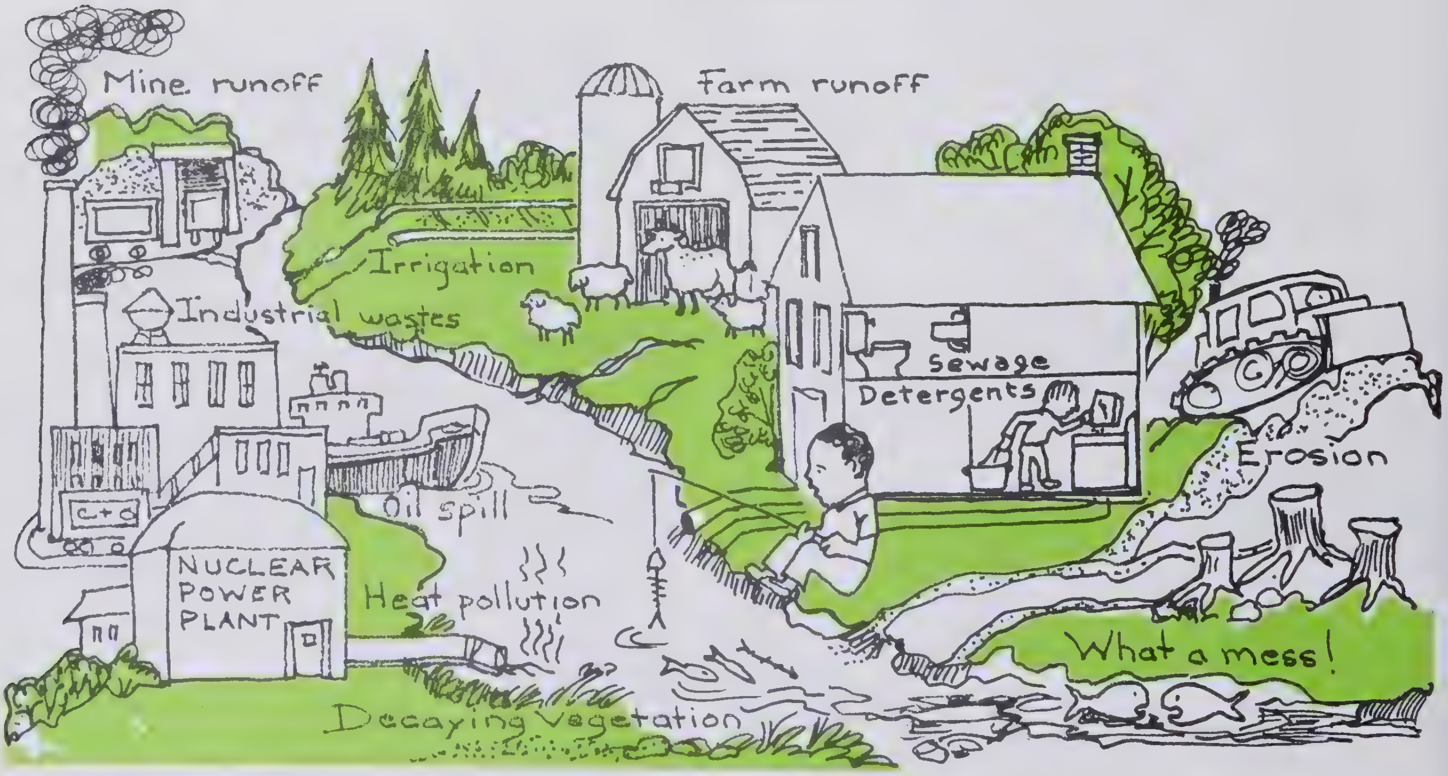
An average family of 4 uses 2400 liters (600 gallons) of water a day. They drink a little of it. They use much more for bathing, washing clothes and dishes, heating the house, flushing away wastes, watering plants, and so on. Water has other uses too.

2. How is water used by each of the following: factories, powerhouses, ships and barges, farms?
3. Water is fun. Can you name 4 kinds of recreation that depend on water?
4. Almost every great city in the world is built on the banks of a river, a lake, or an ocean. Can you explain why?

B. SMELL YOUR LOCAL RIVER

Have you visited a nearby river lately? Did you like the smell? Water pollution seems to be everywhere.

5. The drawing shows some of the main causes of water pollution. How many of these causes can you explain?



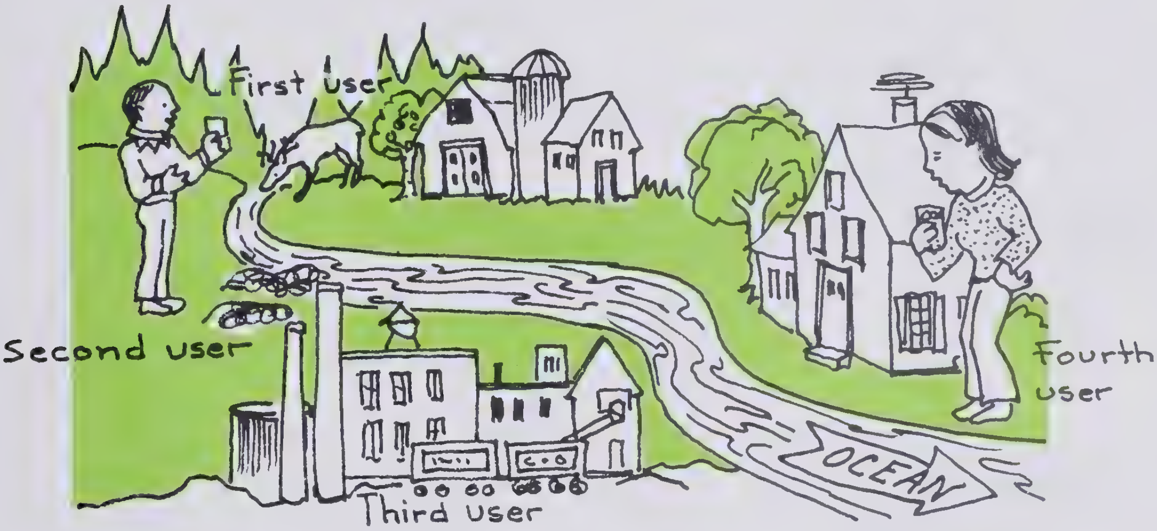
Even the ocean is polluted by oil spills. This is some of the damage that oil spills cause. Young and old chip in to help repair damage.

COURTESY OF COASTAL SERVICES

C. LAKE ERIE IS DEAD

Water pollution is more serious now than it was when your parents were young. Let's see why.

Wastes have always been dumped into lakes and rivers. The wastes are **oxidized,** and the water stays pure. For this reason water in a flowing river can be used again and again by the cities along its banks.



More people, more factories, and bigger cities produce more wastes. The river can't handle them. The oxygen in the water is used up. The wastes aren't oxidized. Instead they **ferment** and pollute the water.

Big, efficient farms add to the problem. Their irrigation water, and the animal wastes from cattle feedlots, contain good fertilizer. The fertilizer overfeeds the water plants in the river.

The plants grow, bloom, die, and decay. They use up what little oxygen is left in the water. Pollution gets worse.

SPERRY NEW HOLLAND

U.S. DEPT. OF AGRICULTURE

This has happened to Lake Erie. The original plant and animal community in the lake has died. The millions of people who live on its shores say: "Lake Erie is dead!"

6. Explain why overfeeding water plants kills a river or lake.
7. Is this happening in a river or lake near your city?

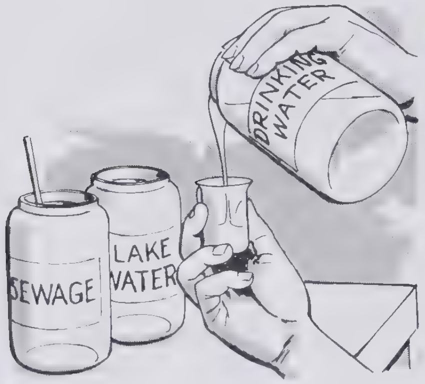
D. SAVE OUR WATER

We don't have to put up with pollution. We don't have to see our water supply shrinking. Here are some things we can do:
Use less water where possible.
Dump fewer wastes into bodies of water.
Treat all wastes before dumping them.
Pour farm wastes on the land instead of into a river.
Find new supplies of water, such as desalting ocean water.

8. Can you suggest other ways to increase our water supply? Can you suggest other ways to reduce water pollution?

The first step in cleaning up a water supply is to test it. You will do this in the WATER-POLLUTION-TEST ACTIVITY.

WATER-POLLUTION-TEST ACTIVITY



A

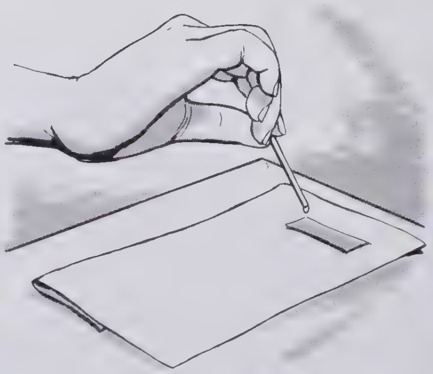
Stir jar before pouring. Then take a sample of each kind of water.

B

Observe color, appearance, and odor of each sample. Copy the WATER POLLUTION WORKSHEET and record all observations.

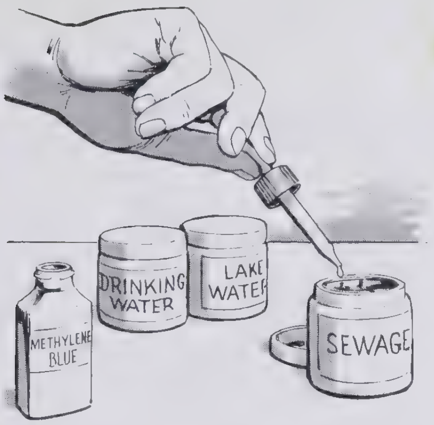
C

Is there any oil on the water samples? Record your observations.



D

Use paper strips to test for pH. pH 7 is neutral, under 7 is acid, over 7 is basic. Record the results.



E

To test for dissolved oxygen, fill small jar completely full of water sample, with no air left inside. Add one drop of methylene blue dye. Seal. Leave until next day. Do this for all 3 jars.

F

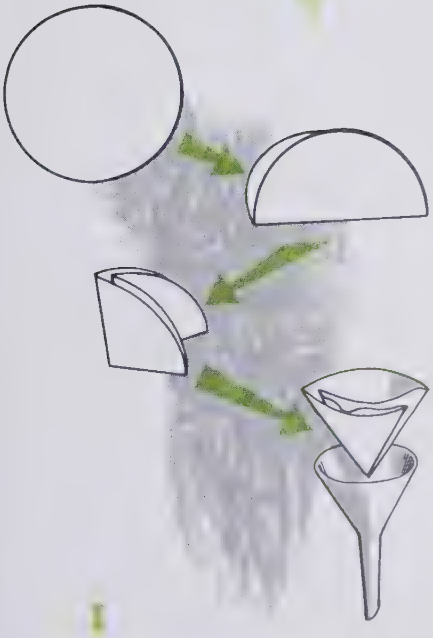
Next day, observe for loss of blue color. Oxygen keeps the color. The less color, the less oxygen in the water. Record your results.

G

To test for **detergent,** fill test tube one-third full with water sample. Cover with plastic held down by your thumb. Shake for 30 seconds. Observe any foam.

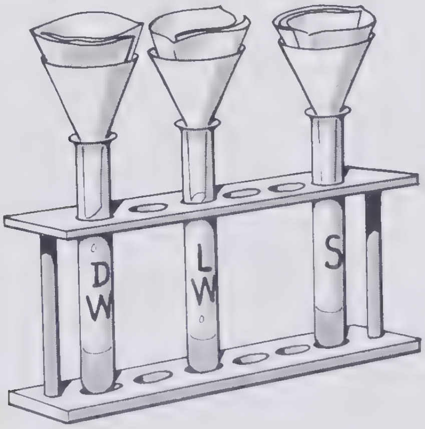
H

Examine with microscope. Note abundance of microbes. Draw typical microbes. Record your results.



I

Fold filter paper, or round piece of paper towelling, like this.



J

Filter each sample. Observe appearance of filter paper, and of filtered water. Record the results.

K

Clean up. Wash your hands well.

WATER POLLUTION WORKSHEET

Test	Results to Look for	Drinking Water	Lake Water	Sewage
Color	Colorless Brownish Greenish Other (describe)			
Appearance	Clear Cloudy Other (describe)			
Odor	No odor Odor present (describe)			
Oil	No oil Oil present			
pH	Acid Basic Neutral			
Dissolved oxygen	No loss of blue color Some loss of blue color How long for blue color to disappear			
Detergent	No foam Foam present How long for foam to disappear			
Microscopic	No microbes Slight growth Heavy growth Draw typical microbes			
Filter	Describe appearance of filter paper Describe appearance of filtered water			

Your conclusion about the quality of the water.

Give reasons for your conclusion.

13 DON'T BREATHE THE AIR

One morning in 1948 many people in Donora, Pennsylvania, woke up with headaches. As the day wore on, the headaches got worse. By evening 5 thousand people were sick.

Two days later, 26 people were dead.

Donora is a steel-making city. A deadly haze of air pollution from the steel mills had caused the illnesses and deaths.

Air pollution causes similar damage in cities all over the nation.

Look up. You can see the haze of air pollution lying over your city.

word guide

asbestos	*as-BES-tuhs*
emphysema	*em-fi-SEE-muh*
friction	*FRIK-shuhn*
hydrocarbon	*hy-druh-KAHR-buhn*
inversion	*in-VUHR-zhuhn*
monoxide	*muh-NOK-syd*
particle	*PAHR-ti-kuhl*
pollutant	*puh-LOO-tuhnt*

A. WHAT CAUSES AIR POLLUTION?

Several different kinds of **pollutants** cause air pollution. The pollutants are either **particles,** or gases, or hazes. The pollutants get into the air mainly from **friction** or from burning.

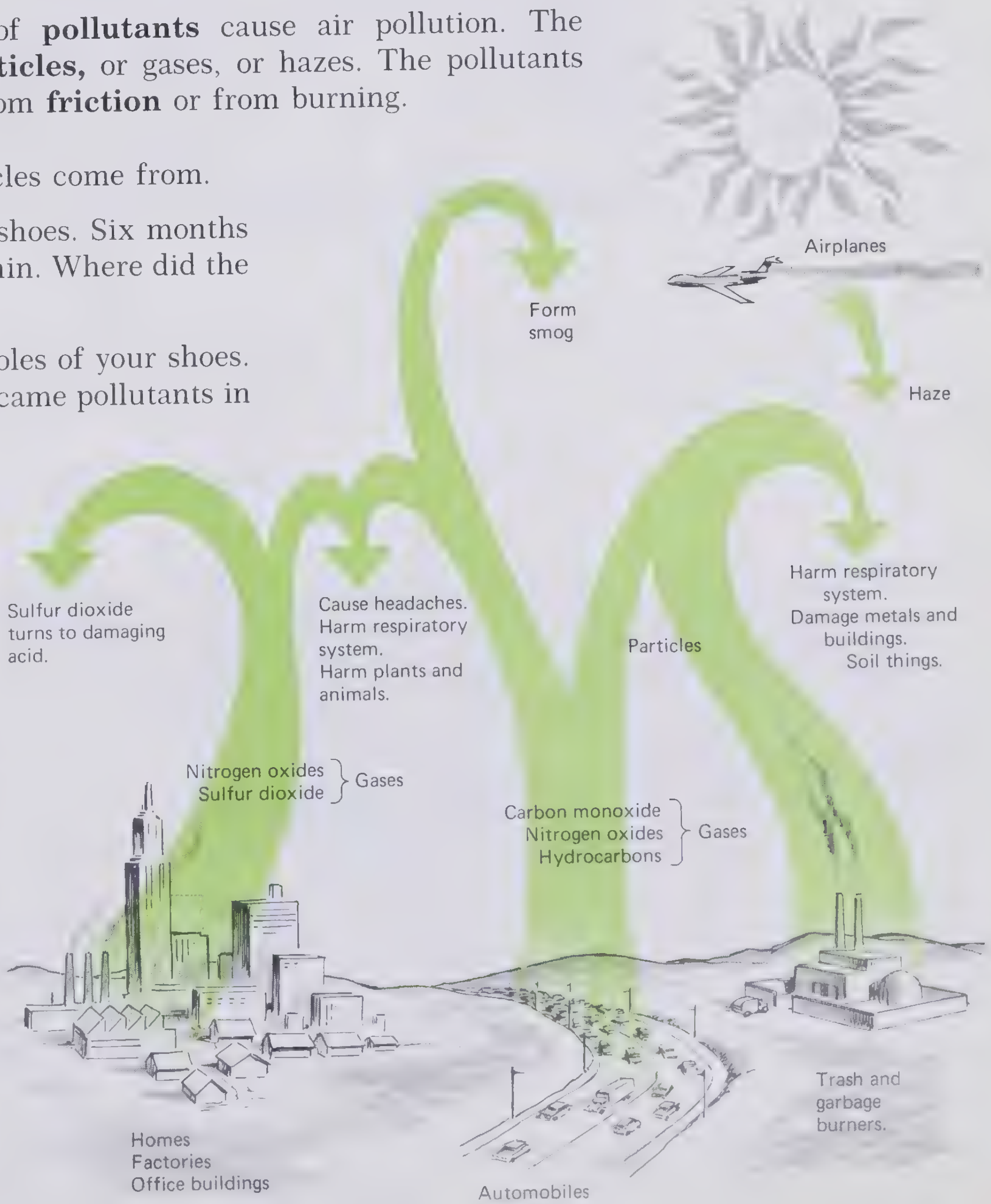
Let's see where the particles come from.

You buy a new pair of shoes. Six months later the soles are paper thin. Where did the leather go?

Friction wore out the soles of your shoes. Particles of the leather became pollutants in the air.

Automobiles produce tiny particles. These particles consist of **asbestos** from the brakes, rubber from the tires, and blacktop from the road.

Soot and ashes are other particle pollutants. They come from burning trash and garbage, from furnaces and chimneys.


Airplanes
Form smog
Haze
Sulfur dioxide turns to damaging acid.
Cause headaches. Harm respiratory system. Harm plants and animals.
Particles
Harm respiratory system. Damage metals and buildings. Soil things.
Nitrogen oxides
Sulfur dioxide
Gases
Carbon monoxide
Nitrogen oxides
Hydrocarbons
Gases
Homes
Factories
Office buildings
Automobiles
Trash and garbage burners.

B. THE FIRE GASES

Several different gases pollute the air. Burning produces these gases.

LOS ANGELES TIMES

Carbon **monoxide** and nitrogen oxides come mainly from automobile engines. Both kinds of gas damage the breathing system. In addition, carbon monoxide causes headache and dizziness. In the right amounts it can kill.

Low-grade coal and oil contain sulfur. When these fuels are burned in furnaces, the sulfur turns to sulfur dioxide gas. This also harms the breathing system.

Damage to metal from air pollution

ENVIRONMENTAL PROTECTION AGENCY–DOCUMERICA

C. THE DEADLY HAZES

You can see haze in the air. The jet from a spray can is a haze. Fog and clouds are hazes made of water vapor. The trail left by a jet airplane is also a water vapor haze.

Water vapor hazes are harmless, except that they cut down the sunlight.

A lung blackened and hardened by disease

ENVIRONMENTAL PROTECTION AGENCY–DOCUMERICA

Hydrocarbon haze comes from automobile engines. It is far from harmless.

What is worse, hydrocarbons combine with nitrogen oxides in sunlight. This combination forms smog. The word smog comes from smoke plus fog.

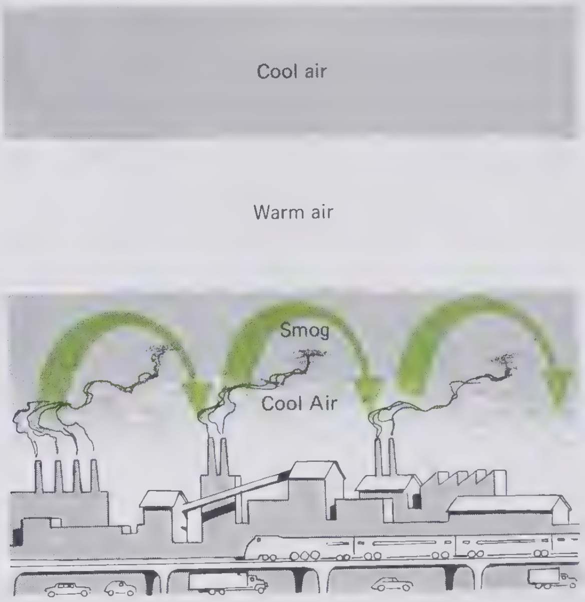
Smog is a killer haze. It slows you down. It irritates the eyes and throat. It causes **emphysema,** a disease of the lungs. It even helps cause cancer.

D. SMOG CITY

Smog caused the trouble in Donora. In Los Angeles, smog is often so bad that doctors tell people with weak lungs to leave the city. The problem in Los Angeles is a weather condition called an **inversion.**

Generally the air gets colder as you go higher. Smog rises into the cold upper air. It doesn't accumulate.

In an inversion, a layer of cold air slides over the city. It holds down the smog. People cough and suffer until winds blow away the cold air, and the smog lifts.

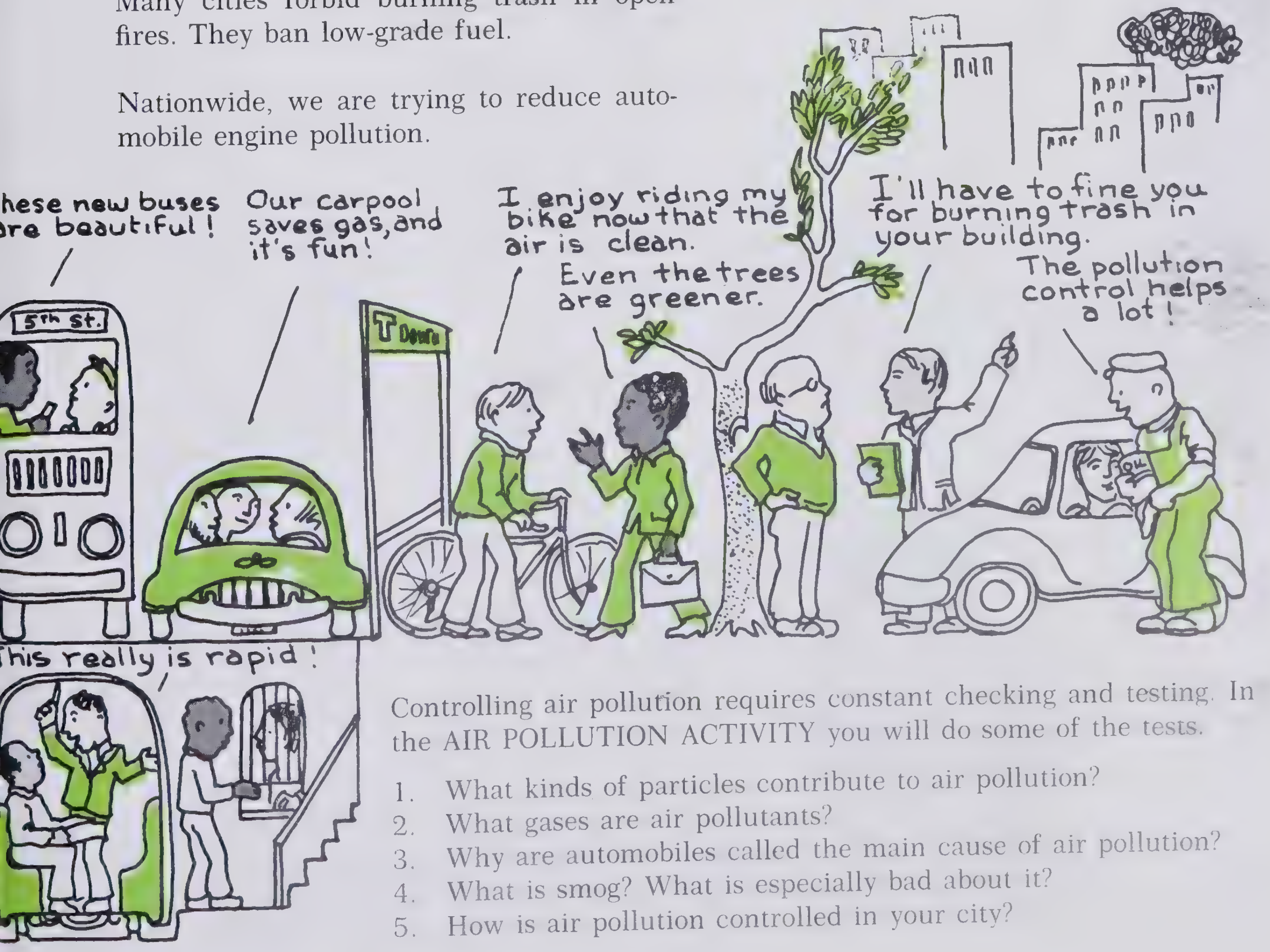


E. CONTROLLING AIR POLLUTION

Air pollution is bad. It destroys property and harms people. People try to do something about it.

Many cities forbid burning trash in open fires. They ban low-grade fuel.

Nationwide, we are trying to reduce automobile engine pollution.


hese new buses
re beautiful!
5th St.
Our carpool saves gas, and it's fun!
I enjoy riding my bike now that the air is clean.
Even the trees are greener.
I'll have to fine you for burning trash in your building.
The pollution control helps a lot!
his really is rapid!

Controlling air pollution requires constant checking and testing. In the AIR POLLUTION ACTIVITY you will do some of the tests.

1. What kinds of particles contribute to air pollution?
2. What gases are air pollutants?
3. Why are automobiles called the main cause of air pollution?
4. What is smog? What is especially bad about it?
5. How is air pollution controlled in your city?

AIR POLLUTION ACTIVITY

PARTICLE COUNTER

A

To make Particle Counter, rule part of card into squares 1 cm ($\frac{1}{2}$ inch) on a side. Place doublestick tape over squares.

B

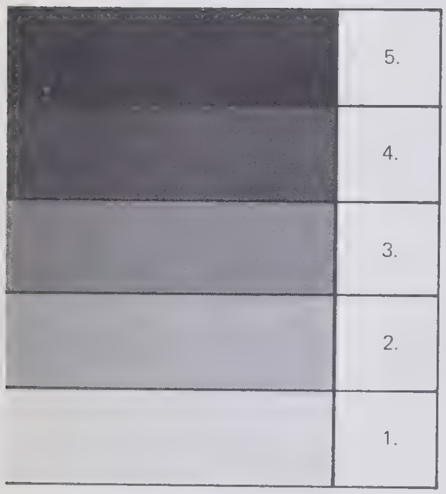
Place Particle Counters in various places—on the floor, on the window sill, in a closet, and wherever else you can think of.

24 HOURS LATER

C

With a microscope, count the particles in 10 squares. Divide by 10 to get the average number of particles per square.

6. Which location had the dirtiest air? The cleanest?



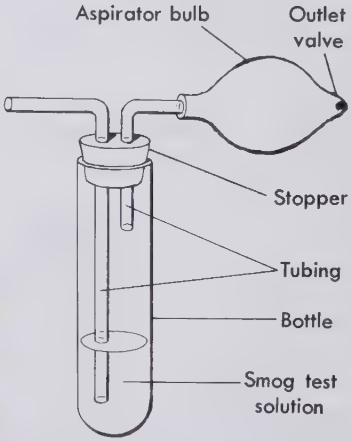
SMOKE CHART

D

Hold the Smoke Chart up against smoke from each chimney you can see. In many communities, smoke darker than No. 3 is illegal. No. 2 or No. 3 smoke may be permitted for a few minutes each hour.

7. Report on smoke conditions in your community.

SMOG DETECTOR



E

Construct this Smog Detector. Fill it $\frac{1}{3}$ full of smog test solution.

F

Work bulb 50 times to blow air through Smog Detector. The worse the smog, the faster the smog test solution turns blue.

G

Test the air in different places and on different days.

8. Under what conditions did you find the worst smog?

14

EVERYTHING MUST GO SOMEWHERE

word guide
meteorite
MEE-tee-uhr-yt
sanitation
san-uh-TAY-shuhn
sludge
SLUJ

You go to the store for a couple of packages of gum. The clerk hands them to you in a paper bag.

On your way out you throw the bag away. You open a package and throw the wrapping away. You take a stick of gum. You throw away the paper and the foil the gum came in.

All over America people are doing the same thing. They throw away plastic wrapping, bottles, empty cans, cigarette butts, old newspapers, broken radios, discarded clothing, rusty bedsprings, and junk of all kinds. It all gets thrown away.

The trouble with this is that there is really no "away."

A. YOU CAN'T THROW IT AWAY

The earth spins around the sun like a giant spaceship. Nothing lands on the earth except sunlight, and a few **meteorites** or shooting stars. Nothing leaves the earth except heat.

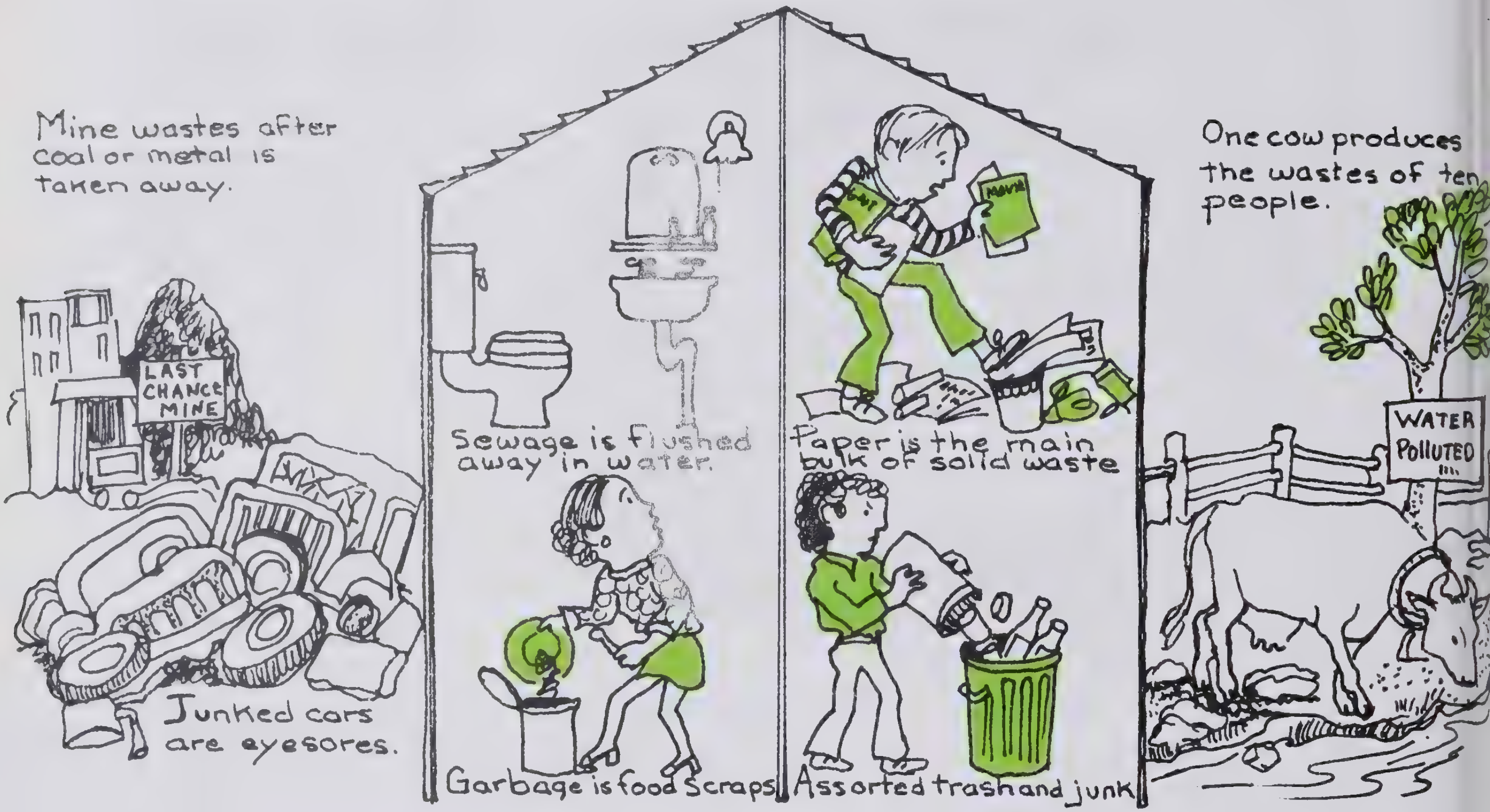
The materials on the earth right now are all that we will ever have. They must last us forever.

We cannot really throw anything away, because we cannot throw things off the earth. All that we can do with discarded materials is to shift them from one place to another. Or, we can change them from one form to another.

B. EVERY LITTER BIT HURTS

Americans discard a lot of material. It averages about one metric ton of solid waste per person each year!

These are the main kinds of solid waste:


Mine wastes after coal or metal is taken away.
LAST CHANCE MINE
Junked cars are eyesores.
Sewage is flushed away in water.
Garbage is food scraps
Paper is the main bulk of solid waste
MOVIE
Assorted trash and junk
One cow produces the wastes of ten people.
WATER POLLUTED

KEEP AMERICA BEAUTIFUL DON'T LITTER

C. AMERICA THE BEAUTIFUL?

Why should we get uptight about all this litter? There are 3 main reasons.

Suppose junked cars are left on the street. Suppose someone disposes of garbage by air-mail—that is by tossing it out the window.

Such habits make the city a mess. This is the first reason. These habits turn America into a vast junk heap.

Suppose our habits are better. We put trash and garbage where **sanitation** men can collect them. What happens to the collected wastes?

DEPT. OF SANITATION, CITY OF N.Y.

Some wastes are burned—with a lot of smell, smoke, and ash. Most wastes are taken to city dumps or landfills.

But cities are beginning to run out of land for dumping. This is the second reason for getting uptight about litter.

Many of the waste materials are useful, like glass, paper, and metal. Some waste materials are scarce or expensive, like the aluminum in beer cans.

If we keep throwing away scarce materials, we are simply putting them where we can't use them. We are going to run out of them. This is the third reason.

D. RECYCLE IT!

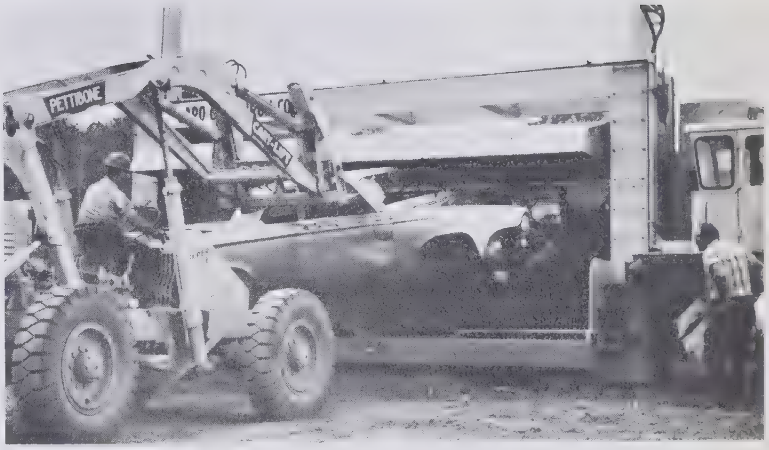
Many cities and industries are beginning to try a better way, recycling. They sort solid wastes, salvage some, and put them back in circulation.

Aluminum beer cans are sold for $200 a metric ton.

Scrap steel is sent back to the steel mills.

Paper is recycled. You may have done this yourself in an earlier activity.

Junked cars are squashed in a giant car eater. Thus, even cars can be recycled.



GENERAL MOTORS CORP.—DETROIT, MICHIGAN

Car eater

E. THE GARBAGE GOLD MINE

This garbage was left on the streets of New York during a sanitation workers' strike. It isn't pretty.

Because they are wastes from living things, garbage and sewage are rich with energy. They, too, can be recycled.

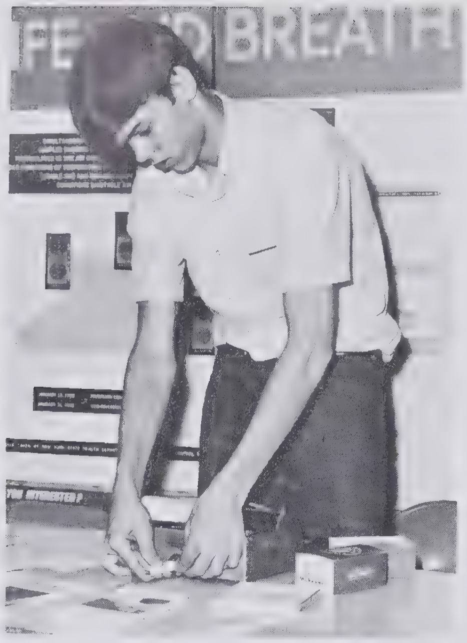
These wastes are pumped to a treatment plant where they are digested by bacteria. The wastes are turned into **sludge.**

DEPT. OF SANITATION, CITY OF N.Y.

Garbage strike

Sewage plant

Sludge has many uses. Sludge can be used to enrich farmland. It can be pressed into odorless building blocks. Sludge can be burned in efficient, pollution-free furnaces to make electricity.



COURTESY OF LINTON HIGH SCHOOL

Andy Fountain

F. THE CRUD COMMITTEE

Kids all over the nation are making ecology, recycling, and the war on litter, their bag.

Andy Fountain was a letterman at Linton High School in Schenectady, New York. He was also chairman of the Crud Committee. He and his group organized a cleanup of litter on the school grounds. They got the principal to reduce the output of trash from the school building. They won public acclaim for making Schenectady a cleaner city.

What can a Crud Committee in your class do?

1. How does the title of this chapter apply to solid waste?
2. Why can't we really throw things away?
3. What are the main kinds of solid wastes?
4. What's good about recycling?
5. Why is garbage valuable?

LITTER ACTIVITY

A

How bad is the litter problem in your classroom? Use the floor plan to pick a section of the room for your group to check.

B

Collect all the litter you can find in your section. Search all possible places.

C

Weigh your collection.

6. How much litter did you collect?

D

Sort your litter. For example: separate notebook pages, gum wrappers, food scraps, empty containers, etc.

7. How many different kinds of litter did you find? Compare your results with other groups.

8. How could this litter be recycled?

9. What would you do about the litter problem in the room?

15

THE PEOPLE BOMB

word guide

agricultural	*ag-ri-KUL-chuhr-uhl*
census	*SEN-suhs*
overpopulation	*oh-vuhr-pop-yuh-LAY-shuhn*
Rillieux	*ree-lee-UHR*

Too many people. The people bomb.

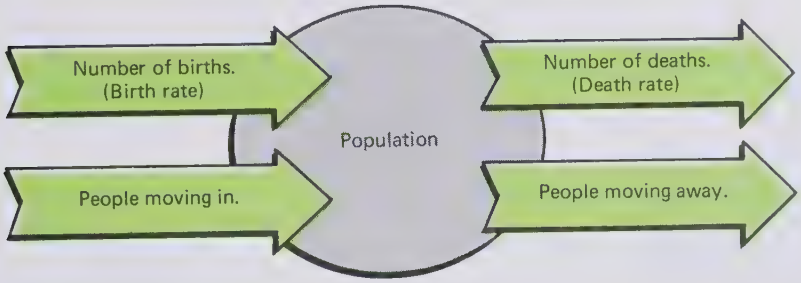
Some think that this is the main cause of pollution. They feel that the people bomb puts an unbearable load on the environment. They are afraid it is going to lay disaster on the world unless we do something about it.

Let's look at the reasoning behind this fear.

A. COUNTING HEADS

How do we know how many people there are? The United States takes a **census** every 10 years. Census workers call at every house and count the people. Most other countries do the same.

In addition, we try to record and count all births and deaths. Officers at our borders count people who enter and leave the country.

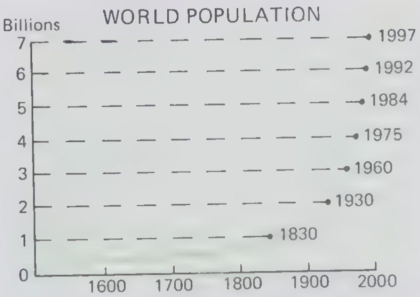


Put all these numbers together, and you have a pretty good idea of the population at a particular time. That is, you have an idea of how many people there are in the country or the community. You can do this with the POPULATION WORKSHEET.

B. HOW MANY PEOPLE?

This graph shows the changing population of the world.

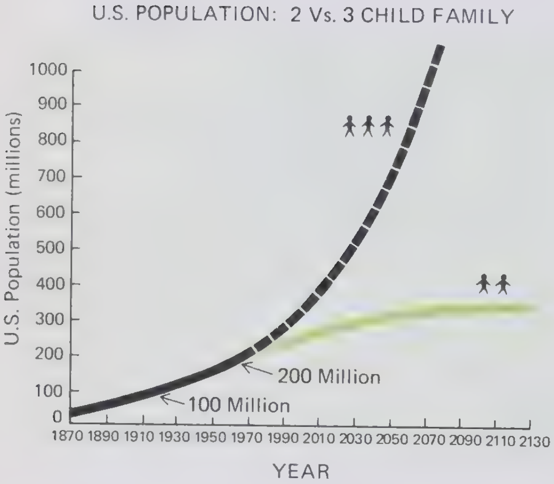
Christ lived during the Roman Empire. From Roman census figures, we estimate that world population was then 250 million. It took 1600 years to double, to 500 million.



1. How many years did it take for world population to double again to one billion? How many years did it take to double a third time?
2. The rate of population growth is speeding up. How does the shape of the graph show this?
3. How can the graph predict what the population will be in future years?

There are 2 possible causes for population growth. The birth rate may go up, or the death rate may go down. Actually, the birth rate hasn't been going up.

However, better health care has cut the death rate. More people are now living long enough to have children of their own. This is the people bomb.


U.S. POPULATION: 2 Vs. 3 CHILD FAMILY

If each family has an average of 3 or more children, the population soars. At an average of 2 children per couple, the population drops. At an average of 2.1 children per couple, the population stays steady; this is called zero population growth.

4. Why does the population drop if the average family has 2 children?

BRUCE ANSPACH/EPA NEWS PHOTO

C. STRESS AND STRAIN

Many people think that the growing world population means trouble ahead. Pollution will increase. Energy and resources will be used up. Food will be short.

Experiments with mice show some other effects of **overpopulation.** John Emlen kept mice in escape-proof rooms. He let the population grow.

As the rooms became overcrowded, strains developed. There were terrible fights. Mothers didn't look after their babies. Some mice ate the babies. Others became nervous and didn't eat at all.

5. How do you think overcrowding affects people?

D. PLOW VERSUS STORK

We are in a race. The race is between the plow and the stork: between food production and people production.

Hunger, poor nutrition, and starvation are not new problems. Food shortages are as old as the human race. No matter how fast the world increases food production, population seems either to keep up or to move ahead.

Somewhere in the world 10,000 people starve to death every day. Many more die from disease because of poor diet. Most of these people live in developing countries such as India, Niger, and Ecuador. These developing nations cannot properly feed their growing populations.

The developed countries of the world try to help. They export food to their less fortunate neighbors. But this is not enough.

Developing countries must be able to grow all their own food. In the last few years they have started to apply modern science to agriculture. A major change has taken place in the amount and even the kind of food they are producing. The change has been so vast that it is called a revolution, the Green Revolution.

E. THE GREEN REVOLUTION

The improved seeds of the Green Revolution created problems. One was how to keep farmers supplied with the fertilizer and fuel oil they needed. Another was how to store and distribute to the people the big crops that the farmers were raising.

Of course agricultural improvements were going on long before the Green Revolution.

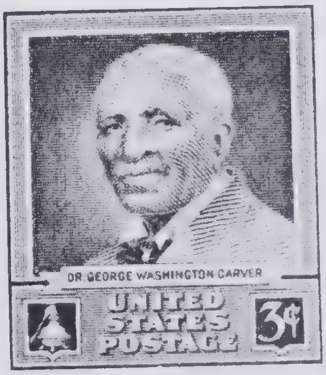
Norbert **Rillieux** was a black, born on a New Orleans plantation in slave times. He studied engineering in France. He remembered how slaves sweated to extract sugar from sugar cane. Rillieux invented a machine that did the job much more efficiently.

6. Will food production keep ahead of people production? Explain your prediction.

COLLECTION OF THE LOUISIANA STATE MUSEUM

F. TWO FROM IOWA

George Washington Carver was another black American. He studied **agricultural** chemistry in Iowa. For most of his life he worked as a scientist at Tuskegee, Alabama. He developed hundreds of new products from peanuts and peanut plants.



COURTESY, U.S. POST OFFICE

THE ROCKEFELLER FOUNDATION

Norman Borlaug is also an Iowan. He has developed new, short breeds of corn and wheat. These are plants used in the Green Revolution. The new plants produce richer crops than the old, tall varieties did.

7. What does the Green Revolution mean to you?
8. How did Rillieux, Carver, and Borlaug help the Green Revolution?

POPULATION WORKSHEET

This WORKSHEET deals with the population of the City of Middletown.

We determine the population change of a community in any year like this:

FORMULA: Births + People moving in − Deaths − People moving out = Population change

EXAMPLE: Determining Middletown's 1973 population change: (Numbers are from table below.)

811 + 132 − 267 − 134 = 542 (Population increase, 1973.)

We determine the population at the end of any year like this:

FORMULA: Population at end of previous year + Increase during year = Population at end of year

OR: Population at end of previous year − Decrease during year = Population at end of year

EXAMPLE: 17,538 (Population at end of 1972) + 542 (Increase during 1973) = 18,080 (Population at end of 1973)

For each year in the following table, find the population change of Middletown, and the population at the end of the year. This has already been done for 1973. Do not write in the table.

MIDDLETOWN POPULATION FIGURES

Year	Births	People Moving in	Deaths	People Moving out	Population Change	Population at End of Year
1972						17,538
1973	811	132	267	134	+542	18,080
1974	803	141	259	149		
1975	827	155	241	164		
1976	849	128	262	158		
1977	861	118	215	131		

Draw a line graph of Middletown's population similar to the graph on page 254 (62). Show the years on the bottom of the graph, and the population on the side. Extend the graph to the year 1985.

1. Is Middletown growing in population, shrinking, or standing still? How does the graph show this?
2. What has been the average population change for the years 1973 to 1977?
3. Predict Middletown's population at the end of 1985.
4. What might keep your prediction from coming true?
5. The Atlas Company, which employs 100 people, is moving out of Middletown. How will the move affect Middletown's population?
6. Suppose you were mayor of Middletown. When you heard about the Atlas Company move, what would you do?

DOING THEIR THING

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DOING THEIR THING

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1 MOLLUSKS

We eat 2 main kinds of shellfish. Oysters, clams, and snails have no legs. They belong to the **mollusk** group.

Crabs and crayfish have many legs. They belong to the group of animals that are called **crustaceans.**

This chapter is about mollusks.

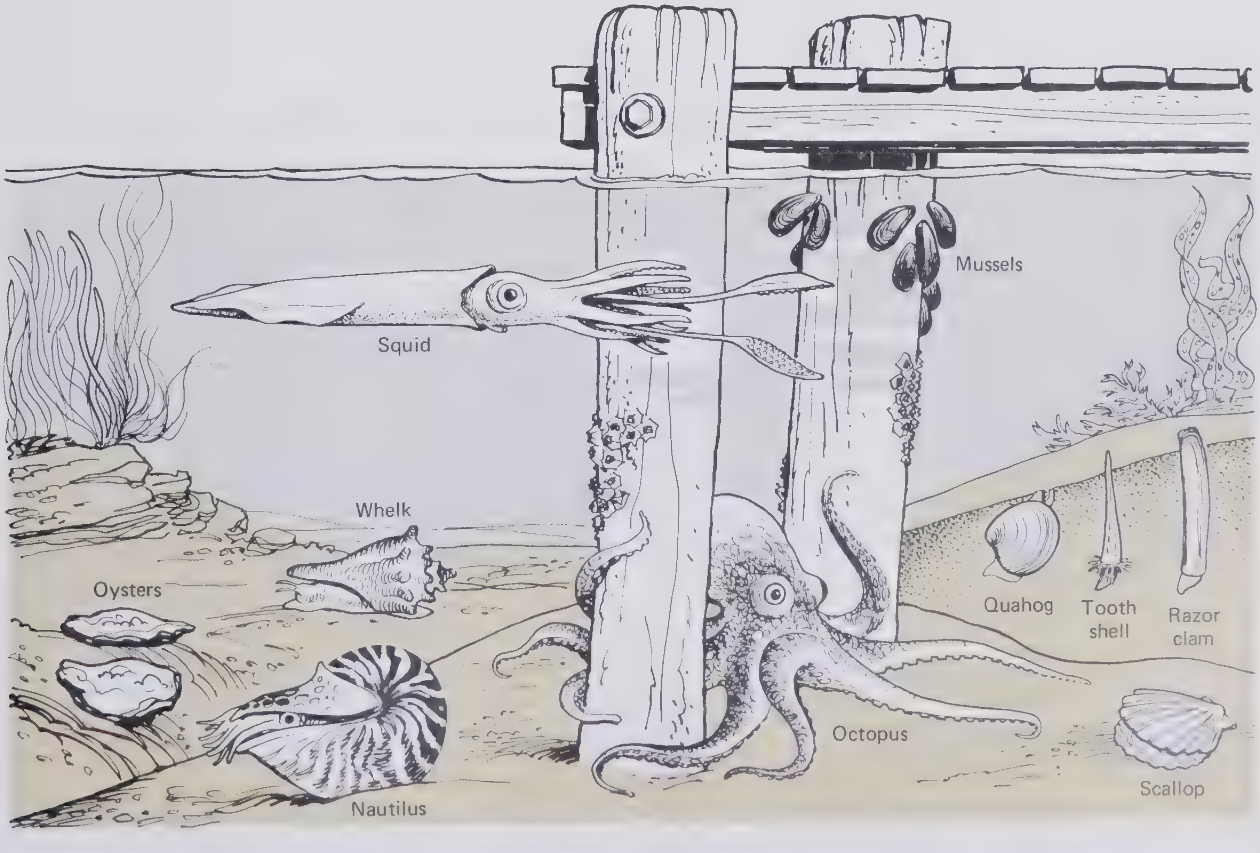
word guide

crustacean
krus-TAY-shuhn
mollusk
MOL-uhsk
mussel
MUS-uhl
octopus
OK-tuh-puhs
scallop
SKAL-uhp
squid
SKWID

A. THE LEGLESS SHELLFISH

Mollusks are the second largest group of animals on earth. Many can be eaten. Besides the 3 kinds mentioned above, we eat **squid, octopus, scallops** and **mussels.**

These animals all have soft bodies which must stay wet. A few live on land, but most mollusks are water animals.



Many mollusks protect their soft bodies with rough, limy shells. Oyster and clam shells are lined with a smooth material called mother-of-pearl.

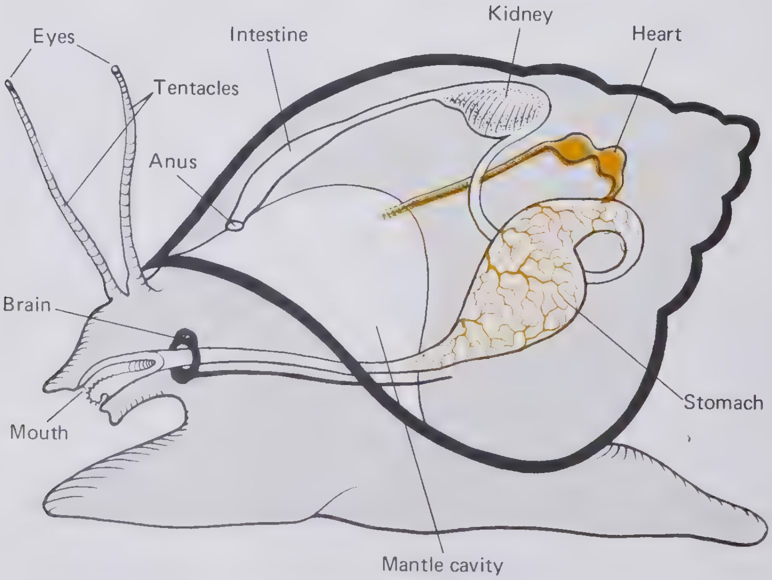
Sometimes a grain of sand gets into an oyster's body. The oyster coats this irritating speck with mother-of-pearl, making a natural pearl. When a speck is placed in its body on purpose, the oyster makes a cultured pearl.

A mollusk added to this girl's charm

B. MOLLUSKS ARE COMPLEX

Many mollusks have a single muscular foot. Snails walk on their foot. Clams and oysters dig into the mud with theirs.

Mollusks have a long digestive tube. It is twisted like ours, rather than being straight like an earthworm's. They also have systems for circulation and excretion. They have brains, nerves, and eyes which function as well as ours do. A mollusk is a more complex little creature than you may think. You will be able to see this in the SNAIL ACTIVITY. You will use either a land snail or a water snail.



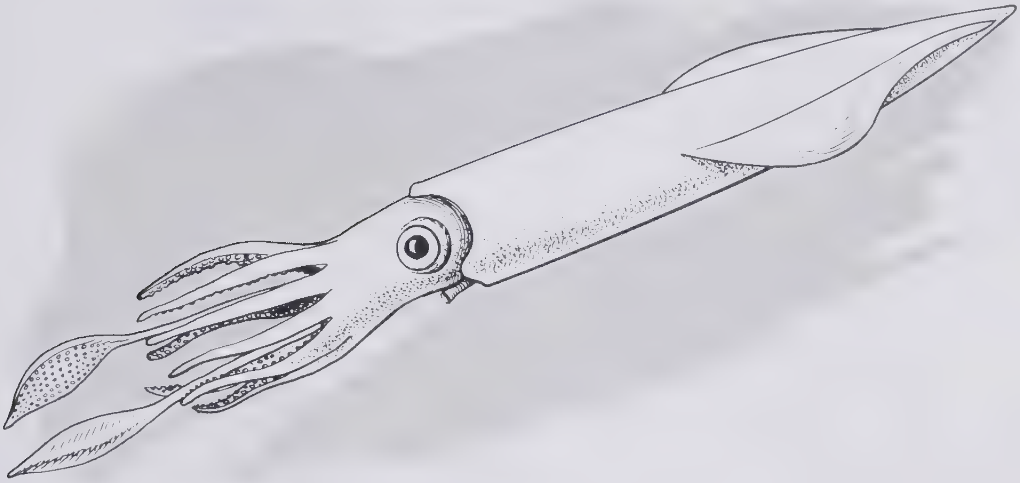
A snail is a mollusk

1. What structures are found both in the snail and in human beings?
2. Can you explain how real pearls are made?
3. Both mollusks and crustaceans are called shellfish. How do the 2 groups of shellfish differ?

C. SQUIDS AND OCTOPUSES

These sea animals are mollusks which have lost their shells. Several long arms have grown from the foot.

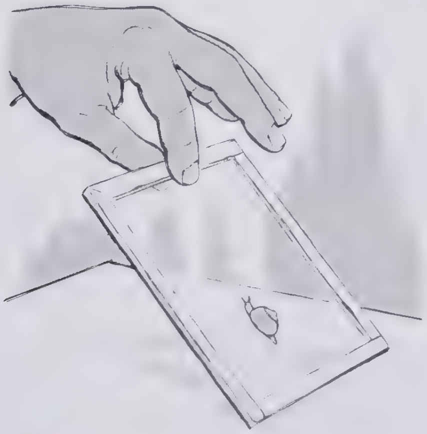
Squids use their 10 arms to catch fish. They swim by jet action.



An octopus walks on its 8 arms. The arms have suckers, which are useful in hunting live food. Squids and octopuses grow big. However, few are big enough to attack people, except in horror movies. Both these mollusks are edible.

4. What mollusks have you ever eaten? What new mollusk foods would you like to try?

SNAIL ACTIVITY



Take a land snail that is out of its shell. Place it on a glass plate. Tilt the plate. Watch the snail walking.

The water snail will walk on the glass wall of its tank.

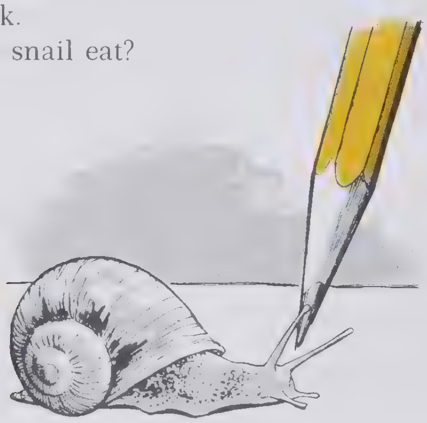
5. How does the snail walk?

B

Put a piece of lettuce on the plate or in the tank. Watch the snail eat.

Normally a water snail eats water plants, including algae that grow on the sides of its tank.

6. How does the snail eat?



C

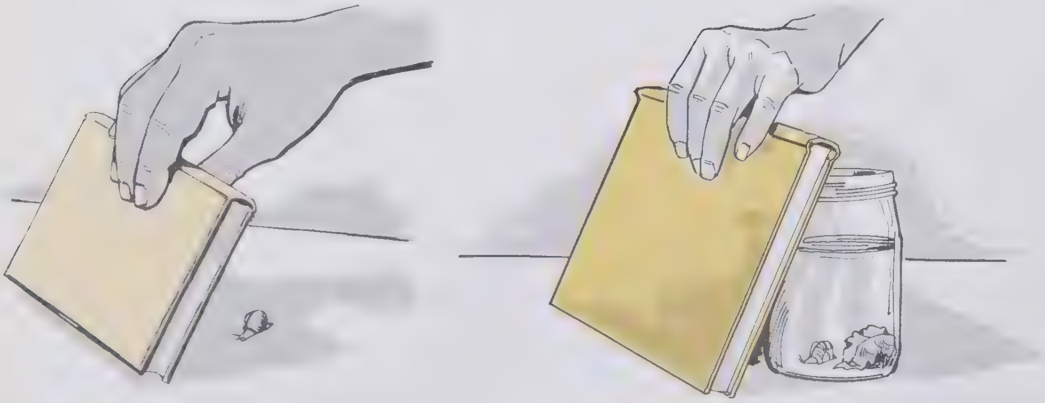
Notice the 4 feelers. Touch them gently with a pencil.

7. What do the feelers do when they are touched?

D

Use a book to block the light from the snail.

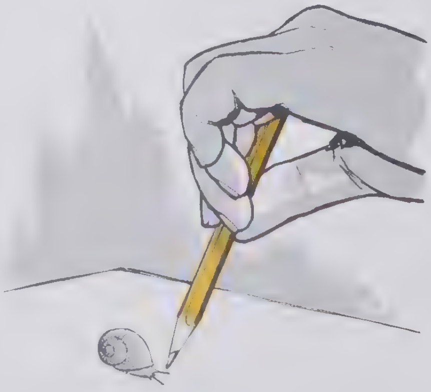
8. What do you think the black spots are on the feelers?



E

Poke the snail until it pulls into its shell. Watch it come out again.

9. How does the snail pull into its shell? How does it come out?



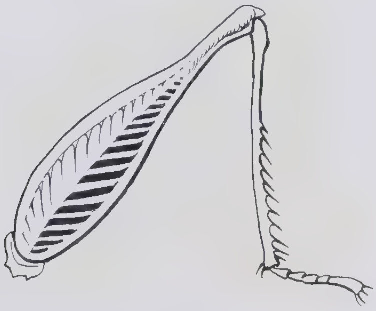
2 THE CREEPY CRAWLERS

This chapter is about legs. It's about legs that creep, crawl, run, jump, climb, swim, dig, fight, work, dance, feel, and grasp.

The legs belong to animals of the jointed-leg group. There are more kinds of jointed-leg animals than all other kinds put together.

word guide

centipede	*SEN-tuh-peed*
millipede	*MIL-uh-peed*
scorpion	*SKAWR-pee-uhn*
sowbug	*SOU-bug*



Jointed leg

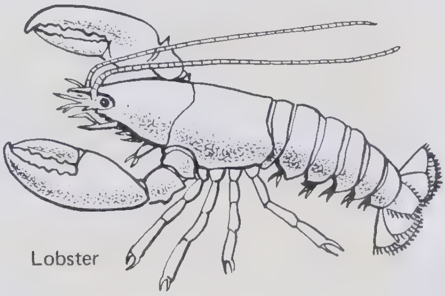
A. WHO ARE THE JOINTED-LEGS?

The jointed-leg group includes spiders and their relatives, insects, crustaceans, and many-legs.

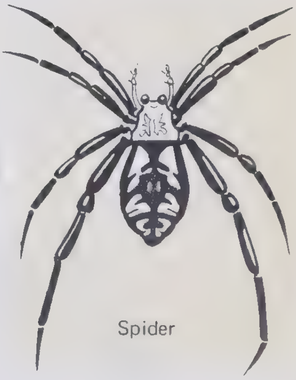
These animals are divided into segments, like the cars in a railroad train. Their body systems are complex.

They have a stiff outer skin. As the animal grows, the outer skin gets too tight. A new, larger size skin develops underneath. The insect, crab, or spider swells to fill the new skin.

Grasshopper



Lobster

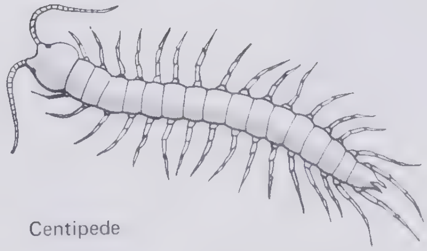


Spider

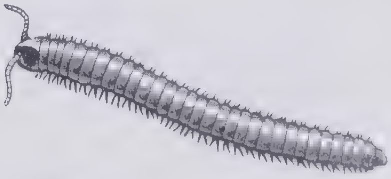
B. THE MANY-LEGS

"The **centipede** was happy quite,
Until a toad in fun
Said, 'Hey, which leg goes after which?'
And blew her mind to such a pitch
She lay all shook up in a ditch
Forgetting how to run."

Centipedes are also called hundred-legs. They have one pair of legs on each body segment. Their speed and their poison glands make them good hunters of small game. They are not powerful enough to harm people.



Centipede



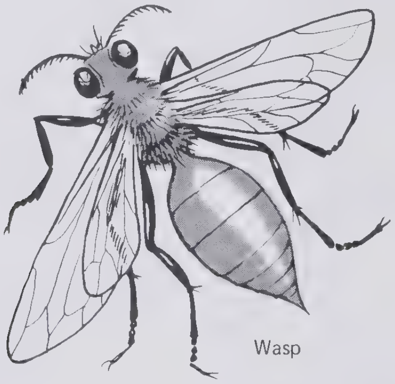
Millipede

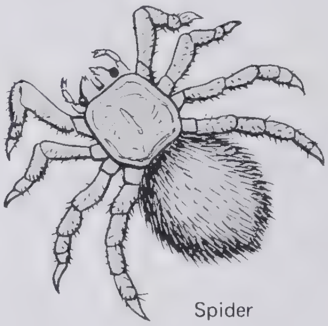
The **millipede** or thousand-legs has 2 pairs of legs on each segment. It moves slowly, and eats only plants.

Both kinds of many-legs are more common than we may think. They aren't seen much because they hide in dark, damp places. They have lots of legs, but not thousands.

C. INSECTS AND SPIDERS

How can you tell an insect from a spider? To answer this question, study the pictures.

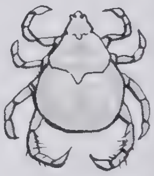

Wasp

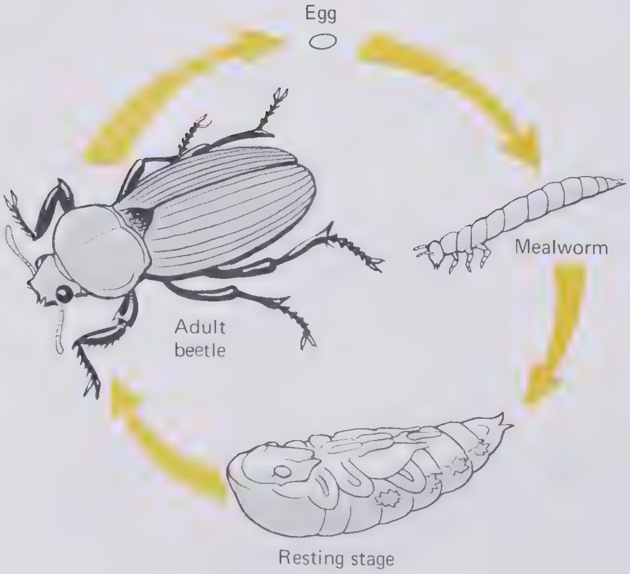

Spider

1. Into how many main parts is the body of each divided?
2. How many legs does each have?
3. Which has feelers?

The relatives of spiders include the poisonous **scorpions.** Tiny disease-carrying mites and ticks are also relatives of spiders.

Scorpion


Tick



D. MEALWORMS ARE NOT WORMS

Insects live everywhere. They are by far the largest group of jointed-leg animals.

Mealworms live in stored grain or cereal. They are insects, not worms. They are the young forms of grain beetles.

The adult beetle lays eggs. From each egg a tiny mealworm hatches. It eats and grows for 4 or 5 months. Then it changes form and rests. After several weeks an adult beetle crawls out of the skin of the resting stage. Many insects go through these stages.

You will have fun, and learn much about insects, by doing the MEALWORM ACTIVITY.

E. THE CRUSTY ANIMALS

Crustaceans make good eating. We eat crabs, crayfish, shrimp, and lobsters.

Crustaceans are shellfish. They live mainly in water. They absorb lime from the water. The lime hardens their outer skin.

A few kinds of crustaceans live on land. Land crabs live in the tropics. Some land crabs climb trees to get coconuts to feed on.

Sowbugs are common in wet woods and damp cellars. You can study sowbugs the same way you study mealworms.

MEALWORM ACTIVITY

A

Place your mealworm in a paper-lined dish. The mealworm is a living creature. Don't put anything harmful on it. You may put things near it.

B

Count the legs, the body segments, the feelers and the jaws.

4. Describe your mealworm.

C

In your notes make a table like this. Touch the mealworm.

5. How does the mealworm respond to touch? Record your observations.

MEALWORM BEHAVIOR

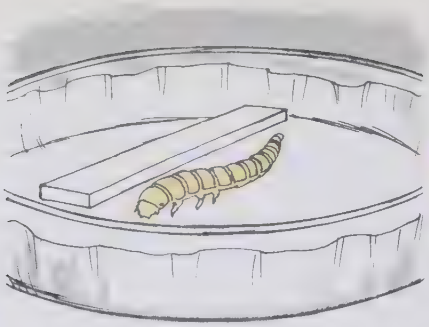
Stimulus	Mealworm's Response
Touch	

D

Take out the paper. Watch through the glass to see how the mealworm walks.

6. How do the legs work together?

7. What does the mealworm do when it reaches the side of the dish? On your table, record what happens.



E

Replace the paper. Put some walls in the dish. On the table, write the mealworm's response to the walls.

F

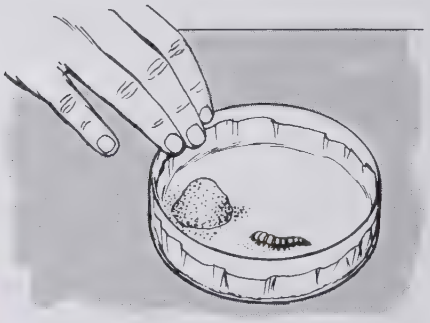
Time the mealworm for one minute.
8. How fast does it walk?
9. Can it walk on a slant?

G

Try to make the mealworm walk backwards.
10. How many ways can you get it to walk backwards?

H

Blow on the mealworm through a straw. Write the response on the table.



I

Place a pile of bran in the dish.
11. How does the mealworm find the bran?
12. What does it do when it reaches the bran?

J

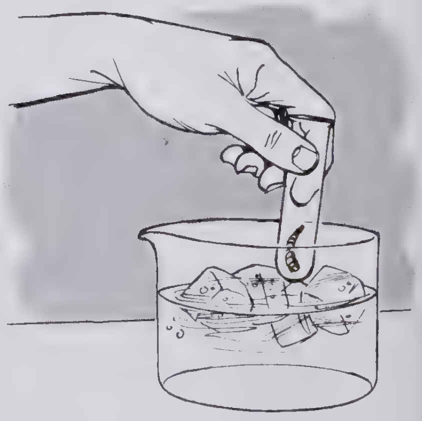
Try other foods.
13. What will it eat besides bran?

K

Dampen half the paper in the dish. Write the response on the table.

L

Cool the mealworm. Write the response on the table.

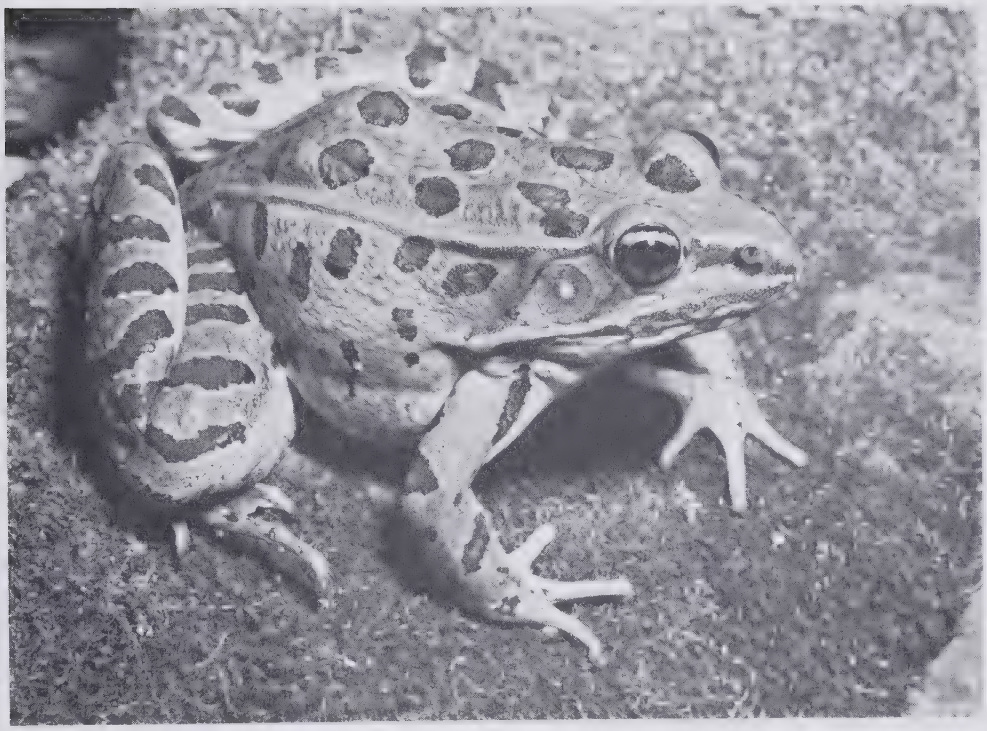


3 THE FROG

"What a funny bird the frog are!
It ain't got no sense hardly.
It ain't got no tail hardly neither.
When it hop it fly almost.
When it stand it sit almost.
When it sit, it sit on what it ain't got almost."

word guide

adapted	*uh-DAP-tuhd*
amphibian	*am-FIB-ee-uhn*
hibernation	*hy-buhr-NAY-shuhn*


JOHN H. GERARD

It seems a shame to spoil this ancient rhyme. But we don't want to mislead anyone. We had better make some corrections.

A. AMPHIBIANS

Of course frogs aren't birds. They are **amphibians.** Toads and salamanders are other amphibians.

The word amphibian means "double life." Frogs, toads, and salamanders lead double lives.

Frog eggs are laid in water. Young frogs, or tadpoles, swim about in the water until they change into adult frogs. As adults, they live mostly on land. The tadpole gets oxygen from the water by means of gills. The adult frog uses lungs to breathe air.

B. THE LONG SLEEP

Frogs and other amphibians are not warm all the time, as your body is. They are said to be cold-blooded.

Actually they are not cold all the time either. Their body temperature changes, depending on the outside temperature.

When the weather turns cold, frogs cool down. They burrow into the mud and sleep all through the winter. This long sleep is called **hibernation.**

Other hibernating animals include many bears, some snakes, and woodchucks or groundhogs.

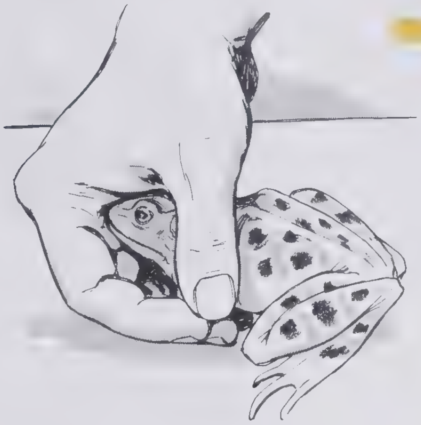
C. THE FROG ADAPTS

You couldn't survive very long in the middle of a lake. Neither can water animals survive on land.

When a frog climbs onto the land, it must be **adapted** to life on land. That is, it must be built, and it must behave, in such a way that it can survive under land conditions.

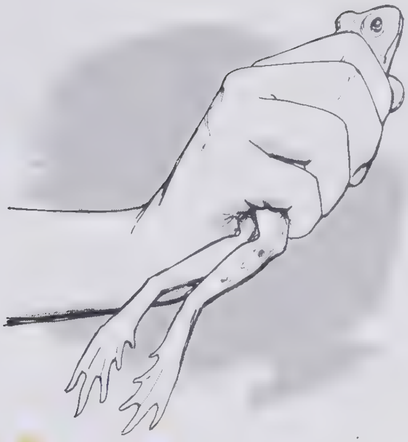
Observe a live frog. You can see for yourself how it is adapted to its way of life. As you do the LIVE-FROG ACTIVITY, answer the questions in your notes.

LIVE-FROG ACTIVITY



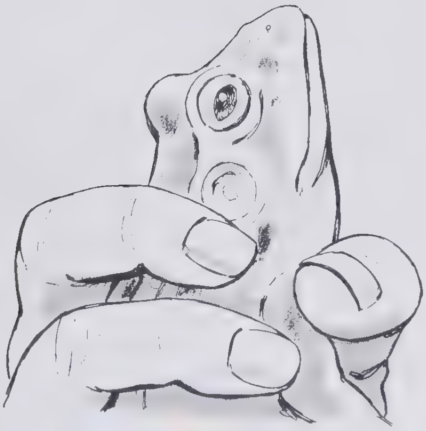
A

Catch your frog like this.



B

Hold it like this.



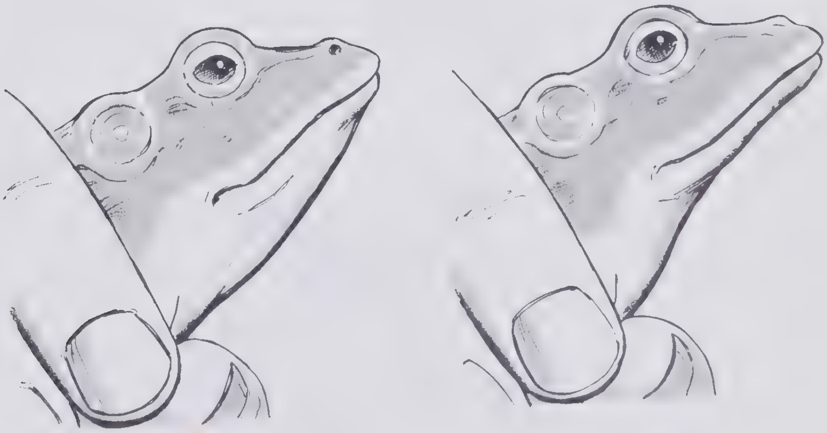
C

Examine its nostrils, eardrums, eyes, eyelids.

1. Compare these structures to yours.

D

Gently touch the frog's eye. Watch the third eyelid blinking.



E

Watch the frog breathe. Count number of times nostrils open and close in one minute. Also count the chin movements.

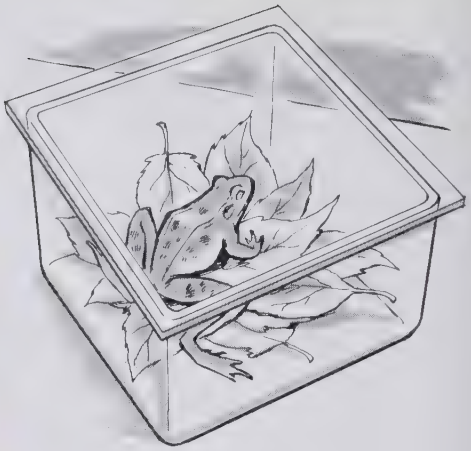
2. Compare the nostril and chin counts.

3. The frog has no diaphragm. How does it breathe?

F

Compare color of skin on frog's back and belly.

4. Of what value is the difference in color? (HINT: Imagine a fish looking up at the frog, or a snake looking down.)



G

Place frog on pile of leaves for a few minutes. Observe the frog's color.

5. How do leaves affect the frog's color? Explain.

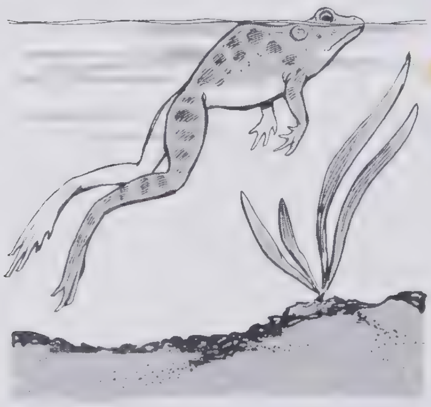
H

Watch the frog jump. Catch it and examine its legs and feet.

6. How do its hind legs help the frog jump? Its front legs?

I

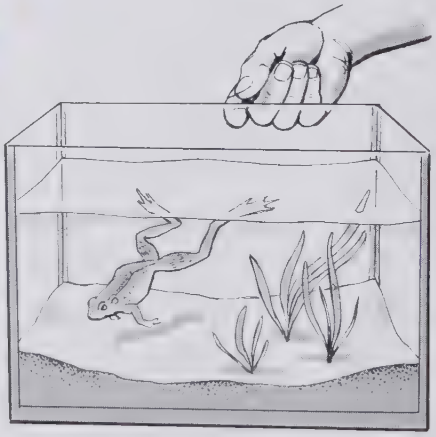
Hold a frog race. The frog that jumps farthest wins.



J

Put frog in water. Watch it float.

7. How does its floating position help the frog?



K

Tap the water tank. Watch frog swim and dive.

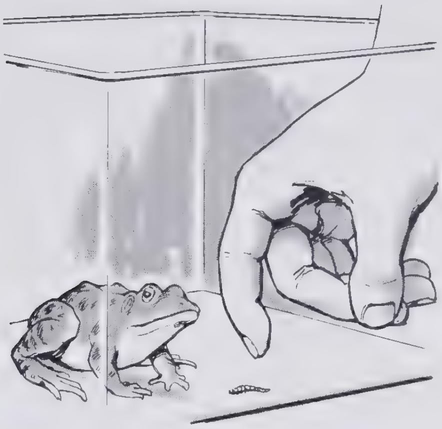
8. Compare the frog's way of swimming to yours.

L

Hold frog under water for no longer than 5 minutes. Watch for breathing movements. Observe eyelids.

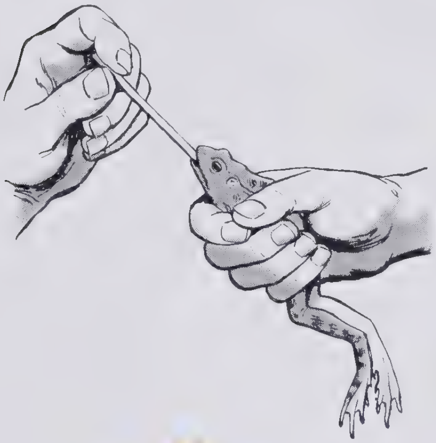
9. Do you see breathing movements under water? (HINT: The frog can breathe through its wet skin.)

10. What good is the 3rd eyelid?



M

Place a mealworm in front of your frog. Watch the frog eat it.



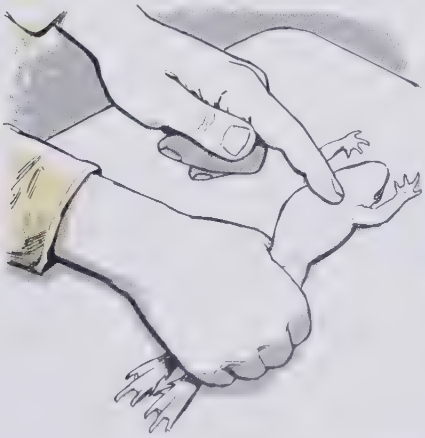
N

Gently but firmly open frog's mouth with tongue depressor. Look for teeth. Examine tongue.

11. How does the frog catch its food?

O

Try to get frog to croak by stroking it, or by spraying it with water.



P

Can you hypnotize your frog? If you succeed, rolling it over will make it recover.

12. This question is the big one. How is the frog adapted to life on land? To amphibian life?

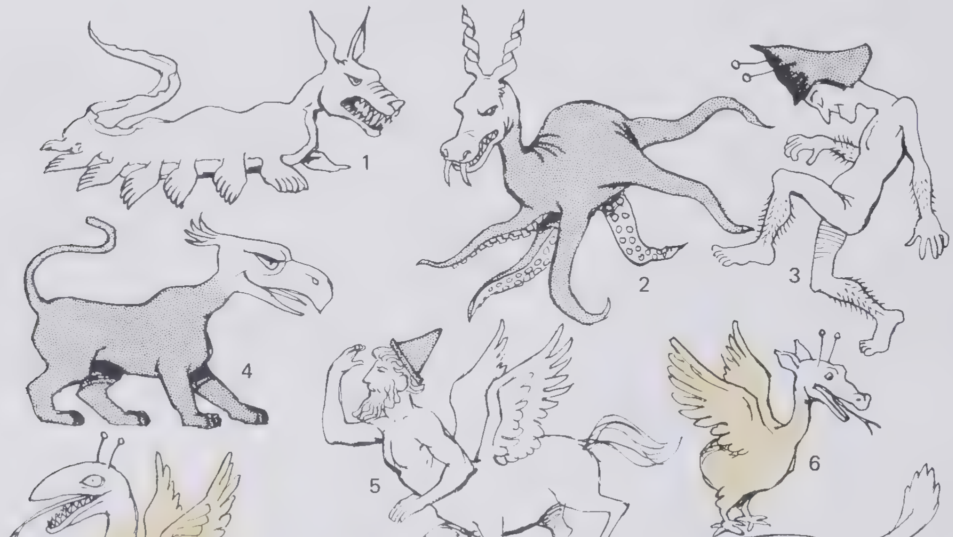
GROUPING WORKSHEET

There are over 2 million different kinds of plants and animals. To deal with such large numbers of living things, scientists place them in groups.

Frogs, toads, and salamanders lead a double life. They are placed in the amphibian group. Grouping depends on the features you think are important.

On the GROUPING WORKSHEET are some make-believe animals. With your team, group the numbered animals according to their important features.

How many different ways of grouping the animals can your team come up with!

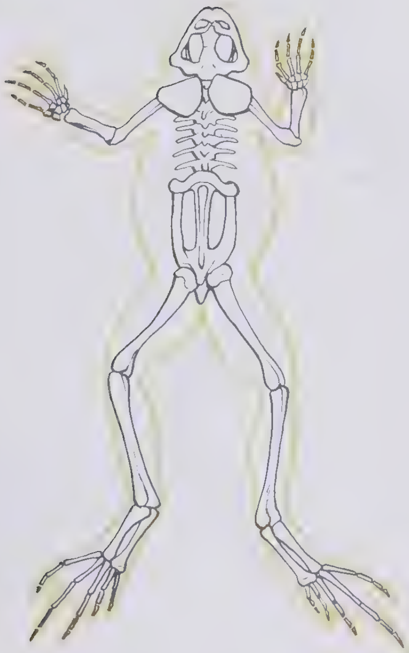


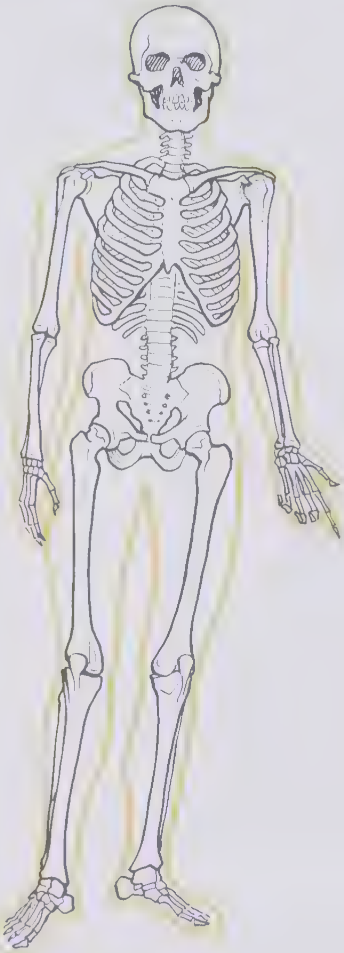
4 DISSECTING THE FROG

Frogs are built on the same general body plan as we are. Doctors and many others are mostly interested in people. But they often find it helpful to learn about people by studying frogs.

word guide

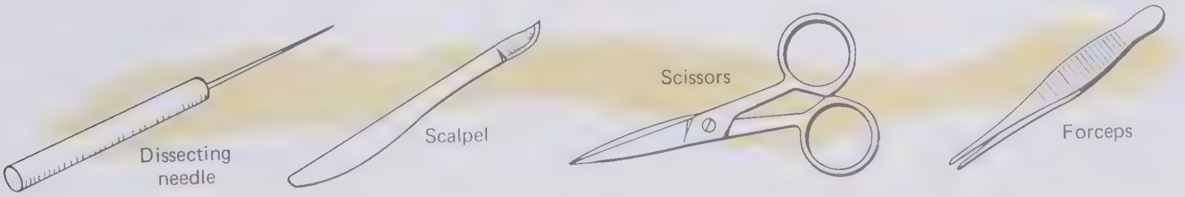
dissecting	*dy-SEK-ting*
forceps	*FAWR-suhps*
pithed	*PITHD*
scalpel	*SKAL-puhl*





One way to study a frog is to dissect it. To some people, **dissecting** means "cutting up." Actually, however, the less you cut and the more you really see, the better dissector you are.

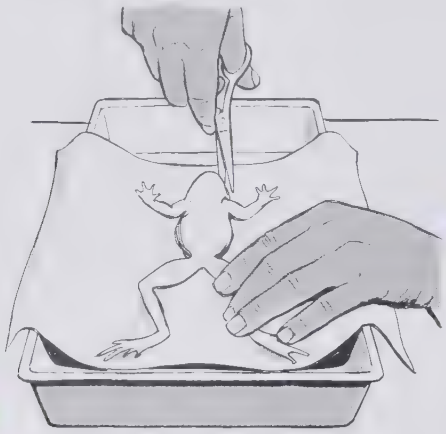
In the FROG-DISSECTION ACTIVITY you will use the instruments pictured below. Wherever you can, use **forceps** and needle rather than **scalpel** or scissors. Cut less and see more.



You may dissect a preserved frog. Or, you may use a **pithed** frog. A pithed frog has been killed painlessly by putting its nervous system out of action.

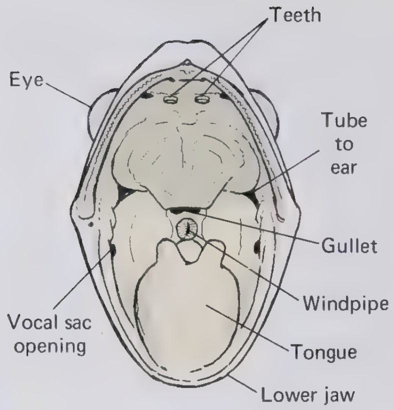
Even though it is dead, some parts of its body remain alive. You will see this in the FROG-DISSECTION ACTIVITY.

FROG-DISSECTION ACTIVITY



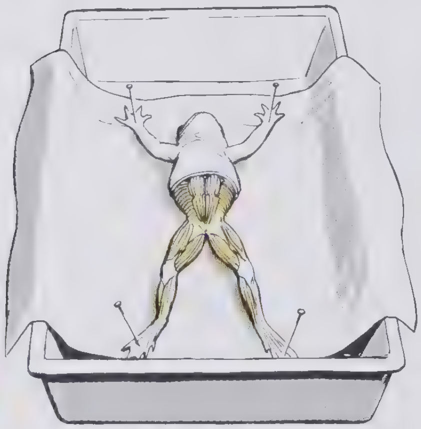
A

Lay frog on paper towel in dissecting tray. Cut corners of the mouth 5 mm ($1/4$ inch).



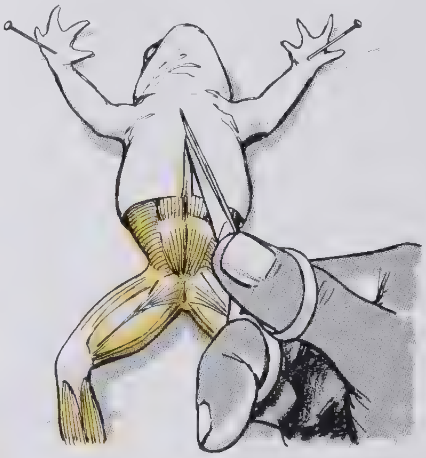
B

Open frog's mouth. Find organs inside. As you gently press on the eyes from inside the mouth, notice what happens.



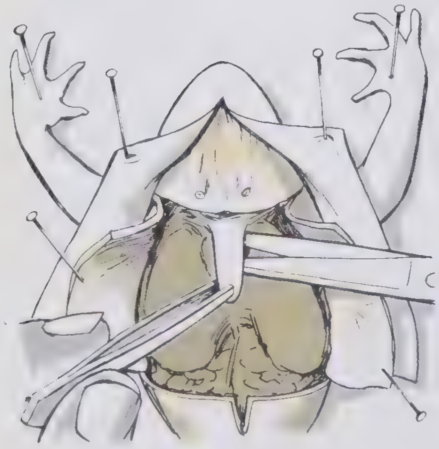
E

Pin frog to dissecting tray.



F

Cut upper skin from waist to chin.

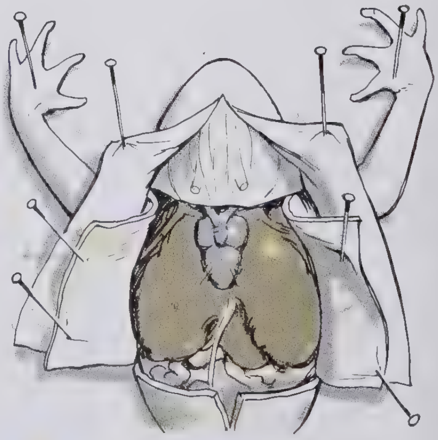


I

Hold scissors flat. Cut under breastbone. Lift breastbone forward and expose beating heart.

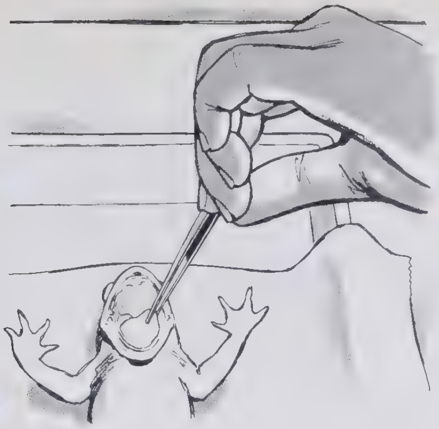
J

If frog is female, body may be full of eggs. Carefully remove them.



K

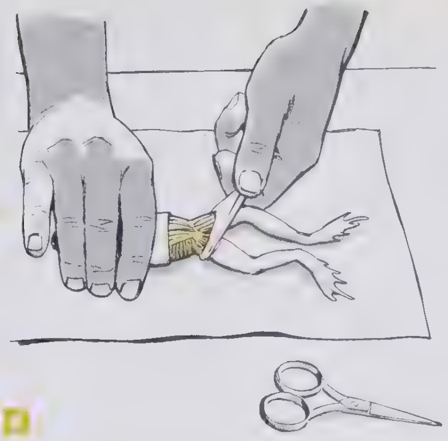
Find large, brown liver. Green gall bladder is under liver. Heart is in front.



C

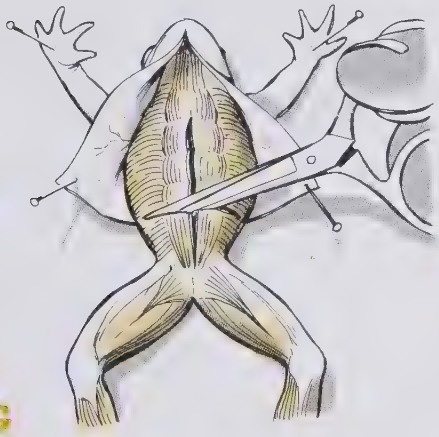
Lift the tongue.

1. Compared to yours, how is it fastened?



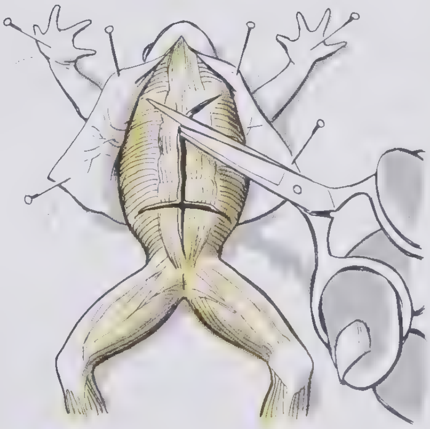
D

Pick up the loose skin at the waist. Cut the skin completely around the frog's body. Hold the upper part of the body. Pull the loose skin down over the feet, off the body. Examine the exposed muscles.



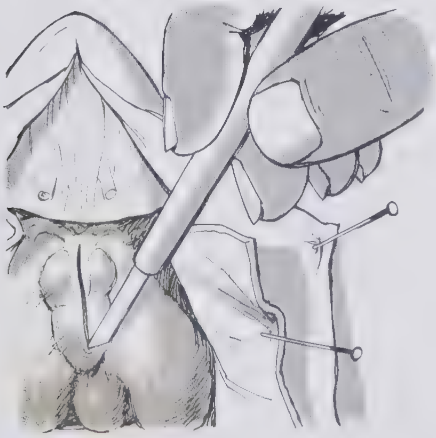
G

Cut muscle layer upward from crotch, on one side of midline. Stop when scissors hit collarbone. Then cut lower muscles across, as shown.



H

Cut collarbones hard, at a slant.



L

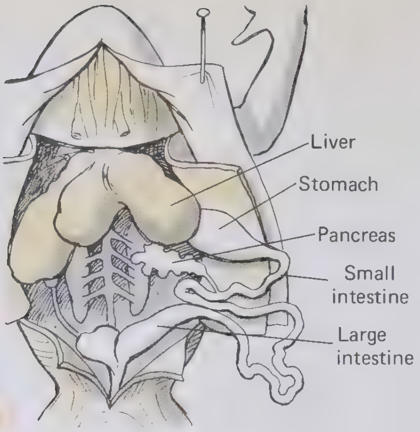
Slit membrane surrounding heart. Note 3 heart chambers, and blood vessels leaving heart. Cut vessels and remove heart.

M

If living heart is kept moist with salt solution, it will beat for hours.

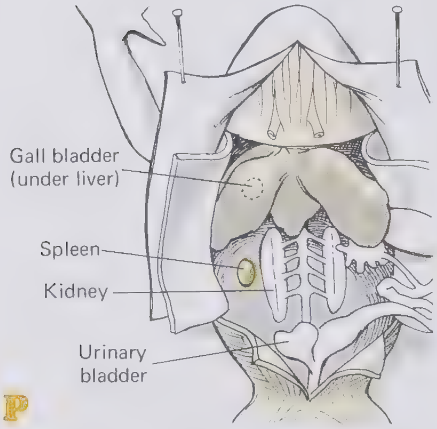
N

Find spongy lungs. Blow them up with dropper placed in windpipe.



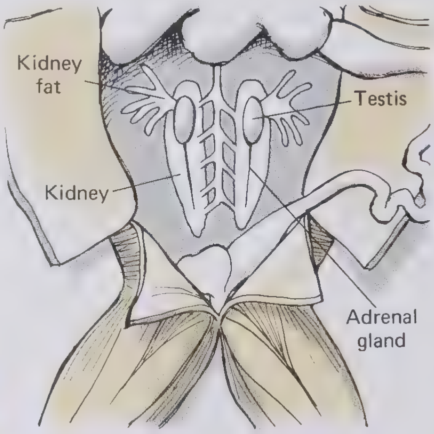
O

Digestive system is a long tube with attached glands. Carefully cut the membranes that hold digestive system and spread it out. Find labelled parts.



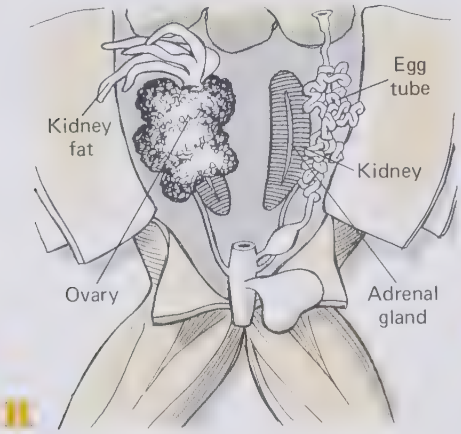
P

The round red spleen helps make blood.



Q

In a male frog, find the organs of excretion and reproduction.



R

Find organs of excretion and reproduction in a female.

S

At back of body, find bundles of white nerves coming from inside spine. Wet nerves and leg muscles with salt solution. Pinch nerves.

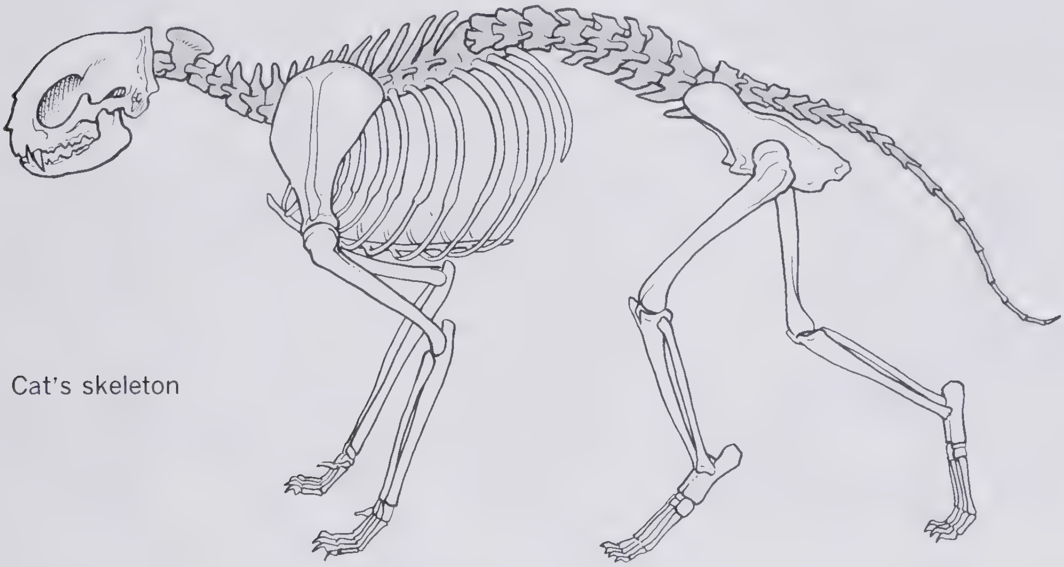
2. What happens?

T

Clean up dissection.

5 TANGRAM ZOO

You have a backbone. You belong to a group of animals called the **vertebrates.** All vertebrates have backbones.



Cat's skeleton

word guide

chimpanzee	*chim-pan-ZEE*
invertebrates	*in-VUHR-tuh-braytz*
ostrich	*OS-trich*
penguin	*PEN-gwin*
tangram	*TANG-gruhm*
vertebrates	*VUHR-tuh-braytz*

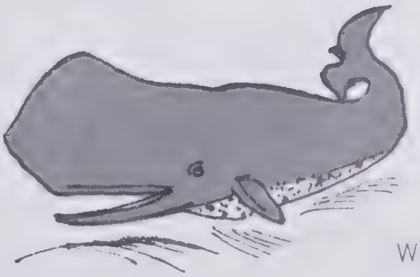
Earthworms and snails are called **invertebrates.** They have no backbones. Most animals are invertebrates.

A. THE VERTEBRATES

There are 5 kinds of vertebrates—fish, amphibians, reptiles, birds, and mammals. The birds and the mammals are most like us. Perhaps that is why we tame these animals, use them, pet them, and study them.

Birds and mammals take care of their babies after birth. Both kinds of animals are warm-blooded and have a 4-chambered heart. Their efficient circulation systems give them lots of energy.

POLAR BEAR



WHALE

B. MAMMALS

Mammals are covered with hair. Some have a lot of hair, like polar bears. Some, like whales, have very little. When the hair is thick, we call it fur.

MAMMALS

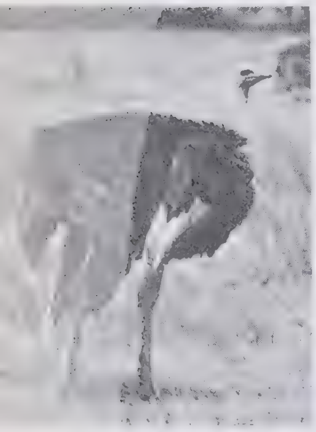
Mammals have well developed brains. People are by far the smartest mammals. But dolphins, pigs, and **chimpanzees** are no dopes.

Along with high intelligence, mammals have a very special method of reproduction. A mammal baby starts developing inside the mother's body.

The mother's care continues long after birth. This long period of care gives the baby time to develop and learn. Going to school is really part of the human mammal development period.

1. How do vertebrates and invertebrates differ?
2. Why are humans classed as mammals?

OSTRICH



GRAHAM WHISTLER
MINISTRY OF INFORMATION, RHODESIA

PENGUIN

OFFICIAL U.S. NAVY PHOTOGRAPH

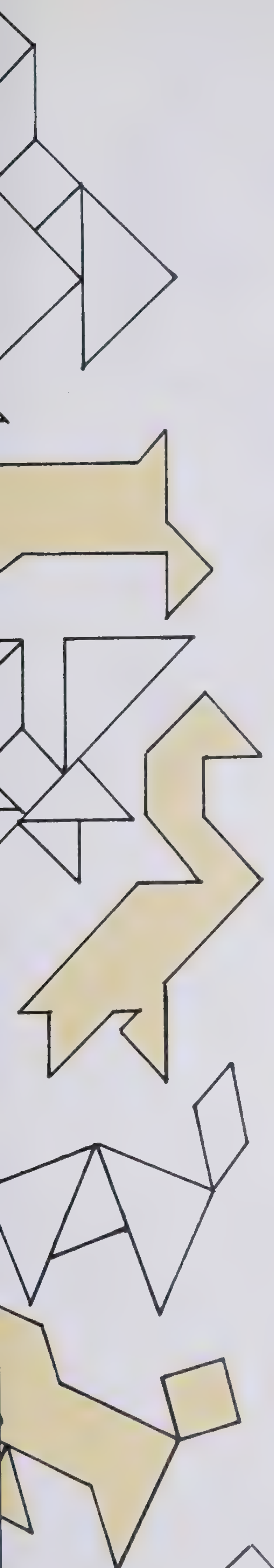
C. BIRDS

Some birds, like **ostriches** and **penguins,** never fly. Ostriches run fast. They have a powerful kick. Penguins swim well, and scoot along the snow on their bellies.

BIRDS

Yet birds in general are built to fly. They have feathered wings, good eyesight, and high body temperature. Their lungs are good. Their bones are light and hollow. Their wing muscles are strong. (Wing muscles make up the white meat of chicken.)

3. What body features make birds good fliers?



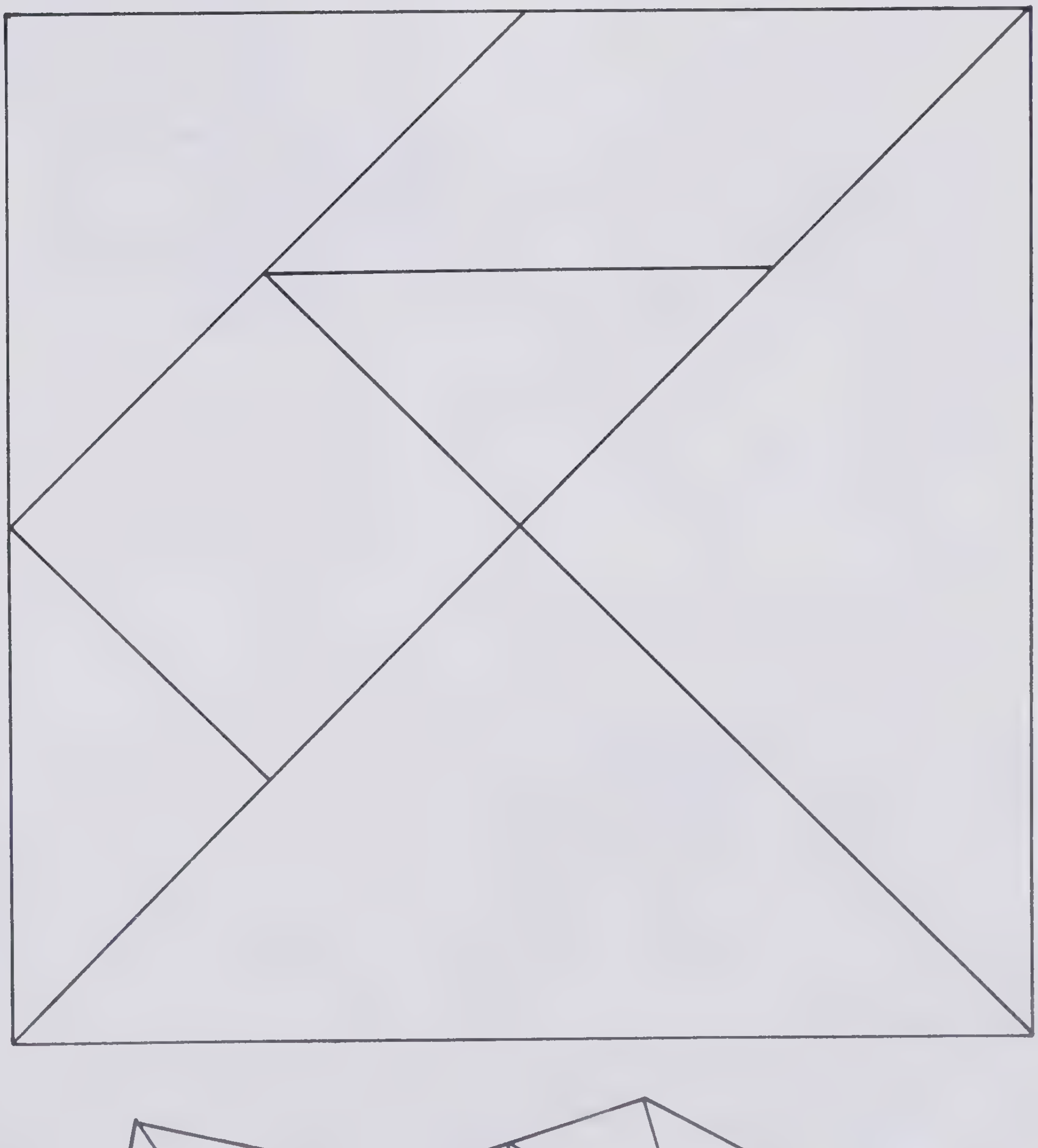
D. TANGRAMS

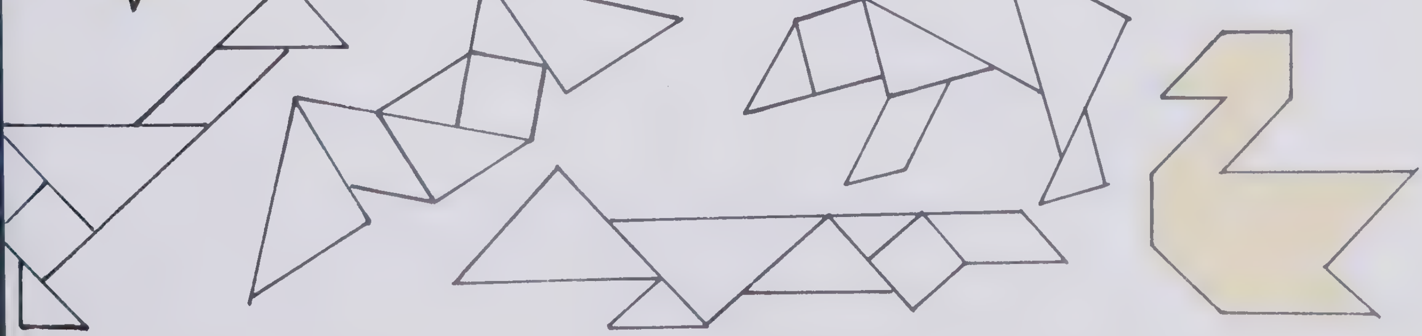
The **tangram** is an old Chinese puzzle. Some animal tangrams and puzzle pieces are printed on the TANGRAM WORKSHEET. Trace the puzzle pieces on a sheet of paper. Then cut them out.

Using the pieces, make a picture of a bird or mammal. You must use all the pieces. Can you make all the animal pictures shown on the WORKSHEET?

4. Can others recognize your animal pictures?

TANGRAM WORKSHEET



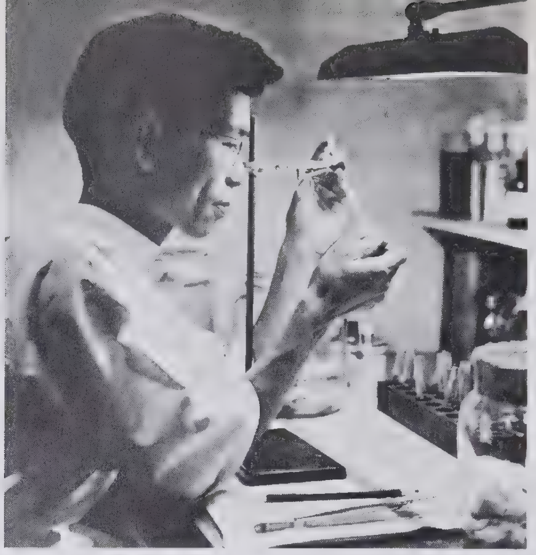


E. ANIMAL BEHAVIOR

By studying animals in the laboratory, we can learn about human behavior.

We can also study animals in their free, wild life. This is called a field study. On your own, do a field study of birds and mammals in your neighborhood. You can observe dogs, cats, squirrels, pigeons, sparrows, or gulls.

Copy the FIELD WORKSHEET and keep a record of the animal behavior that you see. Here are some interesting things to watch for.



OFFICIAL U.S. NAVY PHOTOGRAPH

F. KING OF THE HILL

In the flock of birds or a group of mammals, there is usually one aggressive animal that can chase all the rest. A second animal can chase or peck all but the one on top.

The rest of the group arrange themselves in a pecking order, down to the bottom animal. This timid one runs from everyone. Look for a pecking order in your field study.

G. KEEP OFF MY TURF

Animals such as cats, squirrels, and song sparrows often have territories which they don't let others invade. Some birds sing warnings to "stay off my turf." In your field study, look for territories.

Field Worksheet

Kind of Animal Observed ____________________
Place ____________________
Date observed ____________________
Number of Animals Observed ____________________
Length of Time Observed ____________________

KIND OF BEHAVIOR	COMMENTS
Feeding	
Running or walking around	
Resting or sleeping	
Fighting, threatening, fleeing	
Courting or mating	
Getting or receiving care and attention	
Exploring, investigating, playing	
Imitating another animal	

6

THE AUTOMATIC PERSON

word guide

reflex	*REE-fleks*
response	*ri-SPONS*
stimulus	*STIM-yoo-luhs*

You touch a baby's hand. The baby wraps its hand around your finger.

COURTESY OF BOSTON HOSPITAL FOR WOMEN

A speck gets in your eye. Immediately, the tears flow.

Your hand touches a hot object. Before you even know it, the hand pulls away. You breathe. Your heart beats.

A. REFLEXES

These things are all automatic. A simple, automatic act is called a **reflex.**

Something sparks the automatic act. The spark is called a **stimulus.** You do something in answer to the stimulus. The answer is called a **response.**

Every reflex act involves a stimulus and a response. The speck in the eye, or the hot object, is a stimulus. The flowing tears, and the hand pulling away, are responses.

Some reflexes, like breathing, the beating of the heart, and the working of the stomach, go on inside the body.

Probably you would like to test some of your reflexes. Do the REFLEX WORKSHEET.

Reflex Worksheet

Work in pairs. Alternate as tester and subject. After each test, write down the response in your notes.

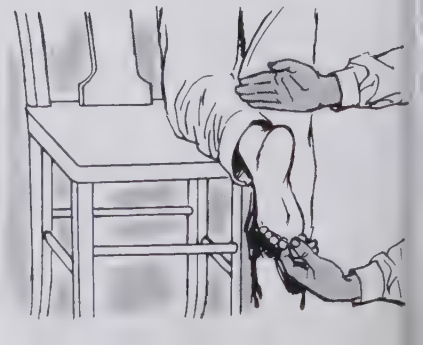
a. Stimulus—Subject closes and covers eyes, opens them after one minute. Tester watches eyes. Response?

b. Stimulus—Subject crosses legs with one leg free to swing. Tester strikes below kneecap with edge of hand. Response?

c. Stimulus—Tester tickles inside of subject's nose. Response?

d. Stimulus—Tester makes one firm scratch along sole of subject's foot. Response?

e. Stimulus—Subject holds arm stiff and away from body. Presses back of hand against wall until shoulder starts aching. After one minute, moves away from wall still holding arm stiff. Response?



f. Stimulus—Subject kneels, with one foot and ankle hanging over edge of chair. Tester presses on big toe and strikes the Achilles tendon in ankle. Response?

g. Stimulus—Tester holds plastic sheet in front of subject's face, tries to make subject blink. Subject tries not to blink. Response?

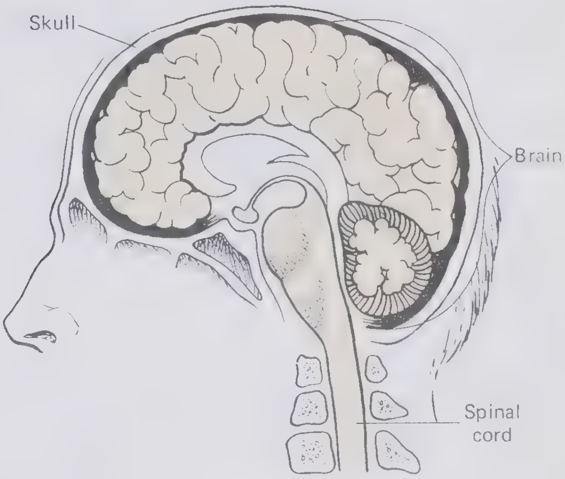
h. Stimulus—Tester watches subject's eyes while pinching back of neck. Response?

B. THE NERVOUS SYSTEM

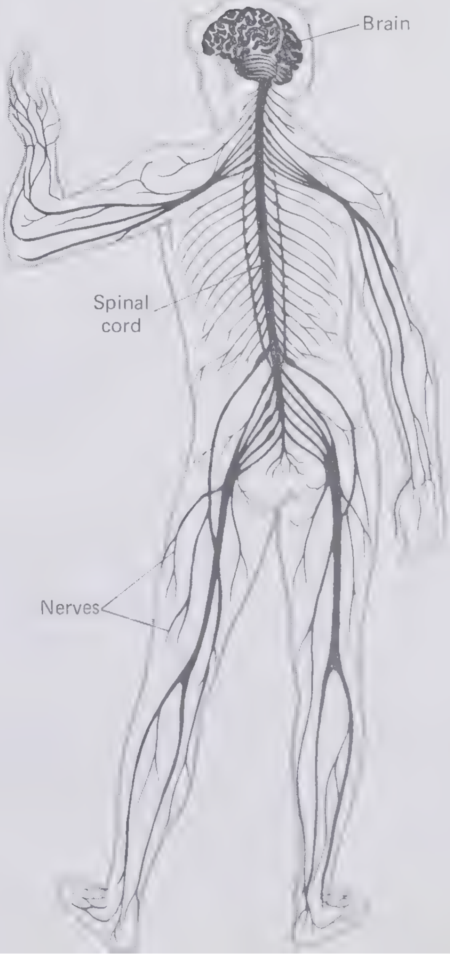
All reflexes work through the nervous system.

The center of the nervous system consists of the brain and the spinal cord. Both of these structures are masses of soft, delicate nerve cells. Both structures are protected by bone.

The brain is enclosed in the skull. The spinal cord starts at the base of the brain. It runs down through the bones of the spine.



Buried in bone, the brain and the spinal cord are hidden from the world. But nerves connect these central structures with all parts of the body.



A nerve is a bundle of long, thin nerve cells, just as a telephone cable is a bundle of long, thin telephone wires.

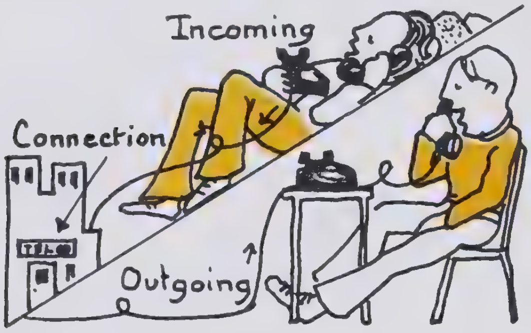
TELEPHONE CABLE

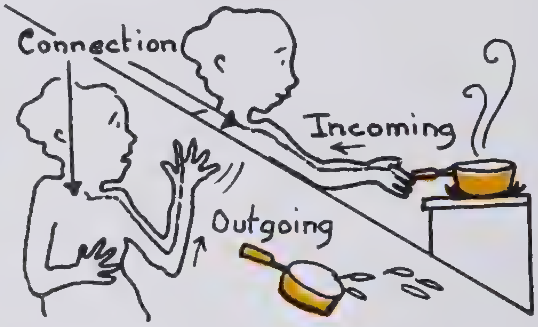
C. HOW A REFLEX WORKS

The nervous system and the telephone system work alike. When you call up someone, a wire carries your voice message to a central office. A connection is made. Another wire carries the voice message to your friend's phone.

Let's compare this to a reflex action. The stimulus, such as a hot object, starts a message running along a nerve. The nerve carries the message to the brain or spinal cord—the body's central office.

A connection is made. Another nerve carries the message back to your arm. The message makes you respond. You pull your hand back.





D. REFLEXES ARE AUTOMATIC

When you are born, pathways that control reflexes are already built into the nervous system. That is why reflexes are automatic. That is why reflexes are hard to control. Try to stop one of the reflexes you have just tested!

Doctors test reflexes. The tests, like those on the REFLEX WORKSHEET, tell whether or not the nervous system is working right.

Reflexes are useful. Some of them protect us. Others keep the body working.

1. Name some reflexes that protect us.
2. Name some reflexes that keep the body working.

E. REFLEXES ARE NOT THE WHOLE STORY

Reflexes take care of basic needs automatically. Thus they free the mind to concentrate on important activities that are not automatic. Activities such as talking, thinking, learning, and feeling emotions are not automatic.

The nervous system can also handle non-automatic activities. It can make new pathways and new connections. That part of the story will be told later.

7 SEEING THINGS

Our eyes are windows on the world. They bring us information.

Each piece of information is a stimulus. We respond to it by doing something or by thinking something.

But sometimes our eyes fool us. This is called an **illusion.** The OPTICAL ILLUSION WORKSHEET shows some of the ways the eyes are fooled.

word guide

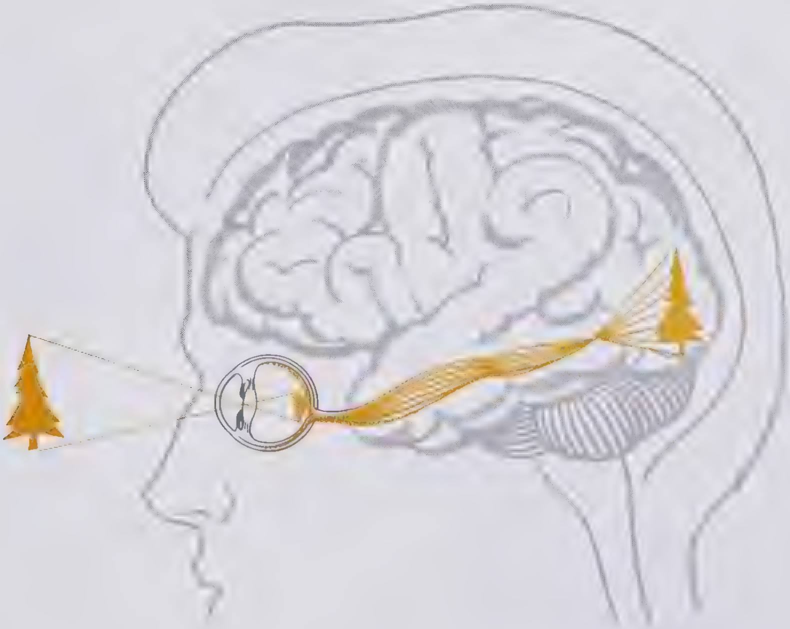
illusion	*i-LOO-zhuhn*
parallel	*PAR-uh-lel*
perceive	*puhr-SEEV*
perception	*puhr-SEP-shuhn*

A. CAN'T STOP THAT JIVING

We may know beforehand how some of the illusions work. Still, we cannot prevent our eyes from being fooled.

The reason for this is that we do not see just with our eyes.

When we look at something, a picture of the object forms in the back of each eye. Nerves carry messages about the picture to the brain. From these messages, the brain **perceives** the picture. Perceive means digging or understanding the picture. We really see with the brain.



Illusions occur because we see things that mislead us. We mistake one thing for another. The brain is thus fooled and perceives the picture incorrectly.

B. TV ILLUSIONS

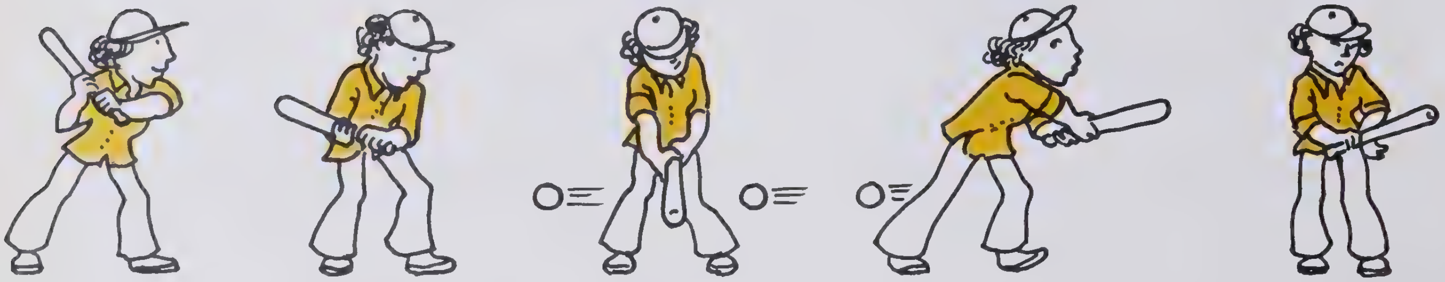
Optical illusions can be useful. Television and moving pictures depend on 2 main illusions.

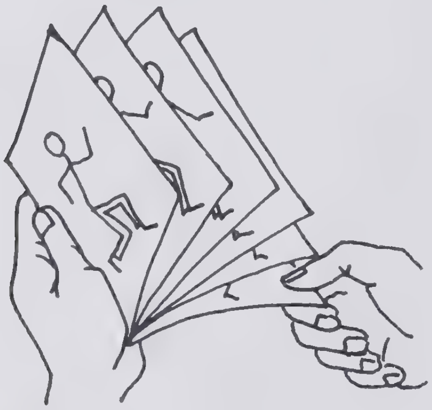
First of all, we think we see a picture continuously on the TV or movie screen. Actually, each picture flashes on the screen for just a fraction of a second. Much of the time the screen is really empty.

However, each picture lasts in our eye until the next one flashes on the screen. The continuous picture is, thus, a useful illusion.

Secondly, the people on the screen do not really move. For each scene, a series of pictures is made. Each picture is a little different from the one before.

This series of slightly different pictures flashes in our eye. We get an illusion of movement.





You can produce the same illusion with a flip book.

C. SIDE VISION

Many states require tests of side vision and depth **perception** before you can get a driver's license. In the VISION ACTIVITY you can measure these abilities.

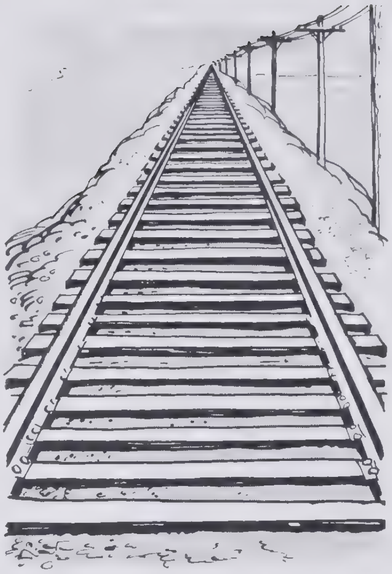
Side vision is seeing out of the corner of your eye. It is not an illusion. Drivers, airplane pilots, basketball players, and hockey players need good side vision.

D. DEPTH PERCEPTION

Depth perception helps us to judge distance and size. It also helps us to see things in 3 dimensions.

Depth perception depends partly on having 2 eyes, partly on illusions, and partly on perception in the brain.

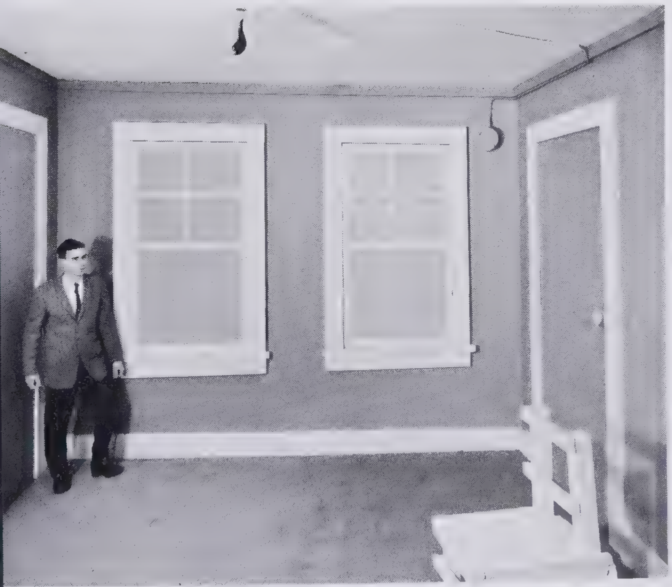
Look at the picture of the railroad tracks.



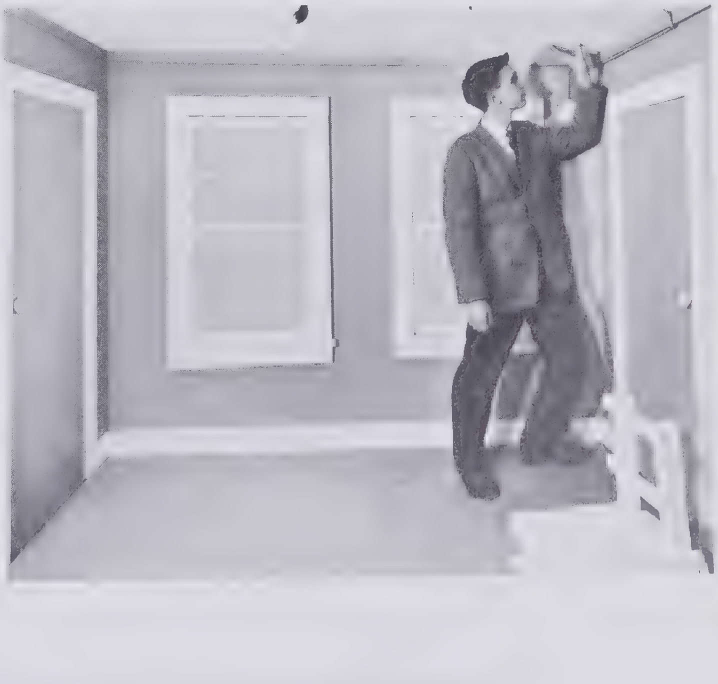
We know the tracks are **parallel** or side by side. Yet as they stretch into the distance, they seem to come together. This illusion helps us to perceive distance or depth.

A distant man looks small. Yet we know his real size. So we use his small appearance to perceive how far away he really is.

False clues can fool our depth perception.



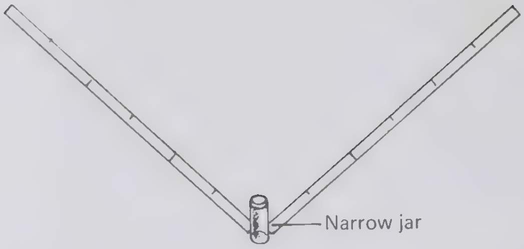
WILLIAM VANDIVERT-SCIENTIFIC AMERICAN, APRIL 1959



Do the pictures fool you?

1. What is the illusion in these pictures? Can you tell the false hints that cause the illusion?

VISION ACTIVITY



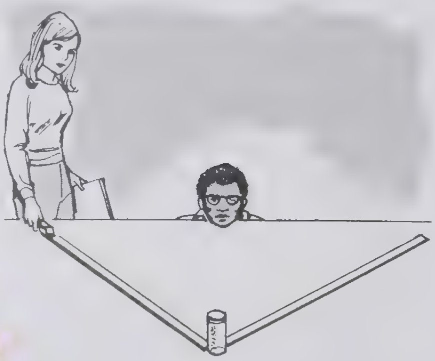
SIDE VISION

A

Use this set-up. One partner is the subject, the other partner is the tester.

B

Subject places chin on table. Closes left eye. Fixes right eye on jar.



C

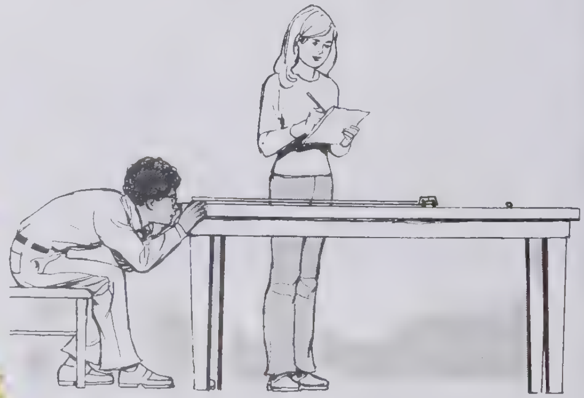
Tester holds colored object at end of one measuring stick. Slowly moves it toward O mark until subject sees it. Note where the subject sees it.

D

Repeat for other measuring stick. Repeat for other eye. Get average of all subject's scores.

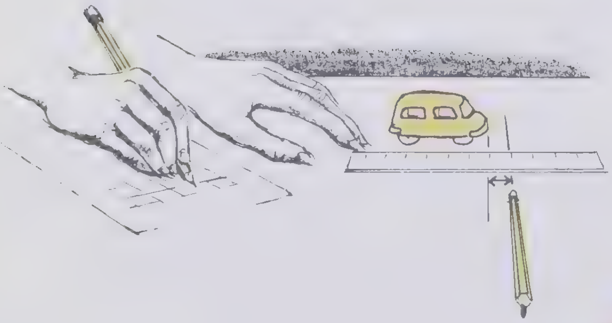
2. What was your side vision score?

DEPTH PERCEPTION



E

Use this set-up. Subject pushes toy car until front of car appears to be in line with pencil.



F

Tester measures car's distance in front of, or behind pencil.

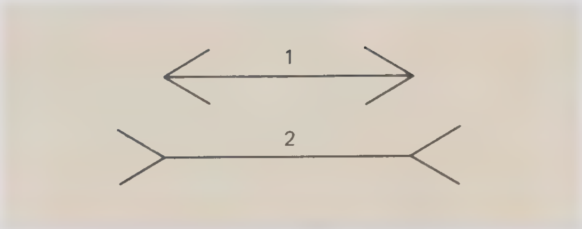
G

Repeat test at least twice. Average the scores. Score of $3\frac{1}{2}$ cm ($1\frac{1}{2}$ inches) is good.

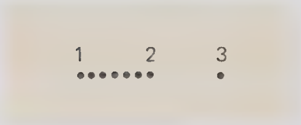
3. What was your depth perception score?

OPTICAL ILLUSION WORKSHEET

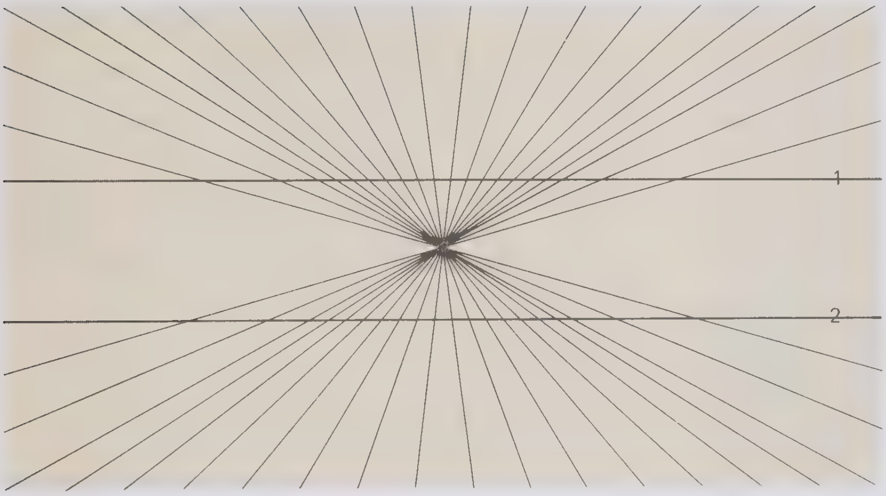
a. Which line is longer? Measure them.

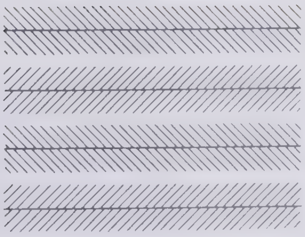


b. Which distance is longer, from 1 to 2, or from 2 to 3? Measure the distances.



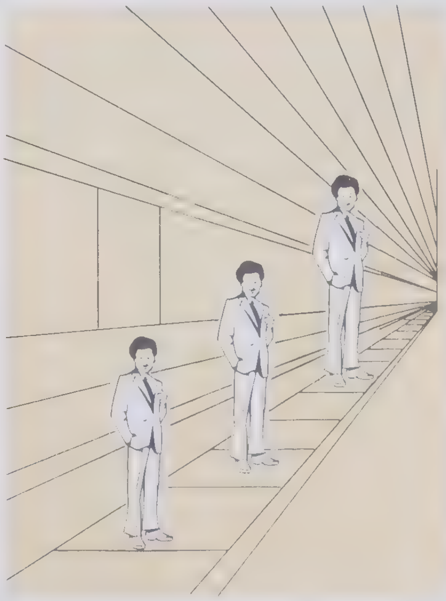
c. Do lines 1 and 2 run exactly side by side? What causes this illusion?

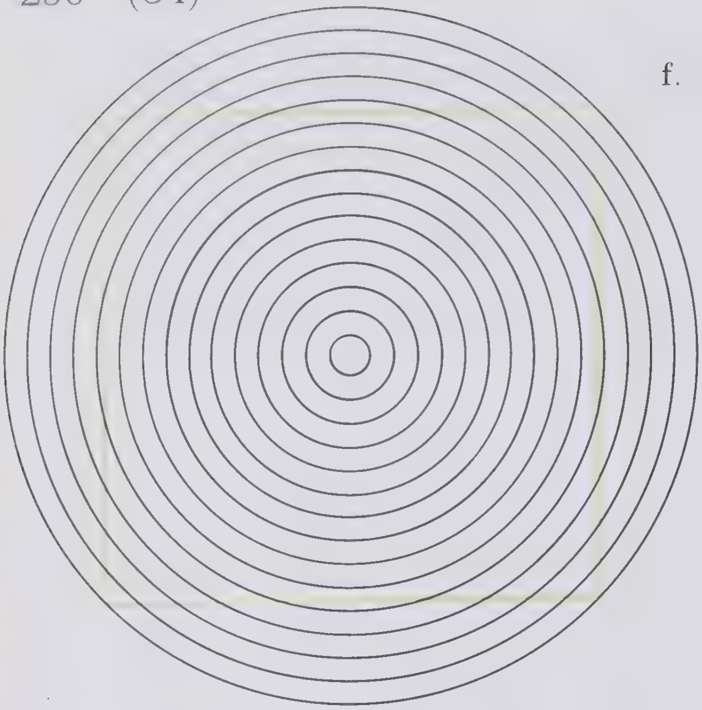




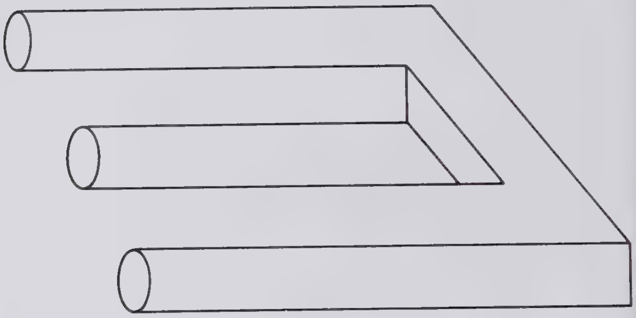
d. Do the long lines run exactly side by side?

e. Are the men the same height? Measure them.

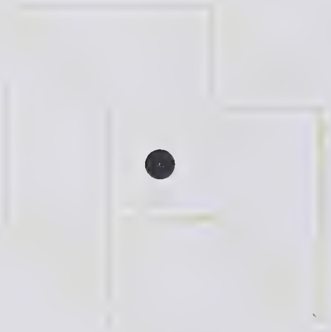




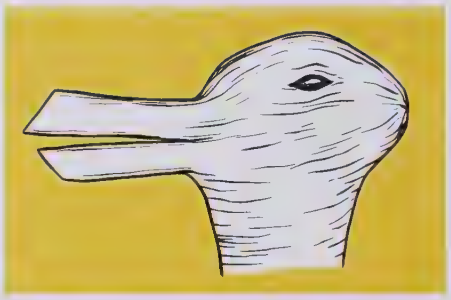
f. Are the sides of the square straight lines? Test them.



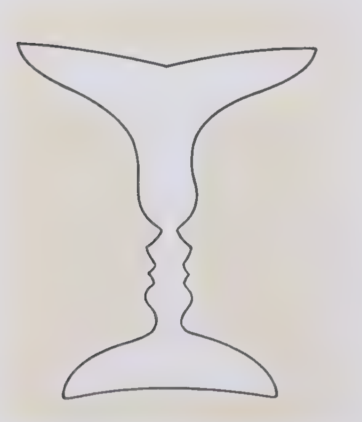
g. Where does the middle prong begin?



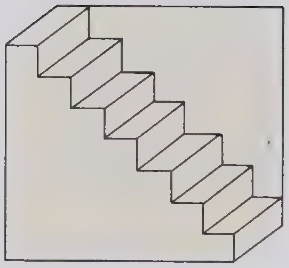
h. Look at the box steadily. Is the dot on the front wall or the back wall?



i. Is this a duck's head or a rabbit's head?



j. What do you see?



k. Is the staircase right side up or upside down?

8 SKIN SENSE

Perhaps you have heard of the so-called 5 senses. Sorry, but you have heard wrong. We have many more than 5 senses.

We see and hear. We smell odors. We have 4 different senses of taste, and at least half a dozen skin senses. We also have a sense of balance, a muscle sense, and a joint sense.

A. SHE READ WITH HER FINGERS

From the age of 2, Helen Keller was blind and deaf. She could not talk. She had no real contact with other people. She was a wild, savage child.

Yet Helen Keller grew up to be a warm-hearted, brilliant, famous woman. She wrote books, gave lectures, and did charity work. She had a host of friends. She was respected and loved.

AMERICAN FOUNDATION FOR THE BLIND

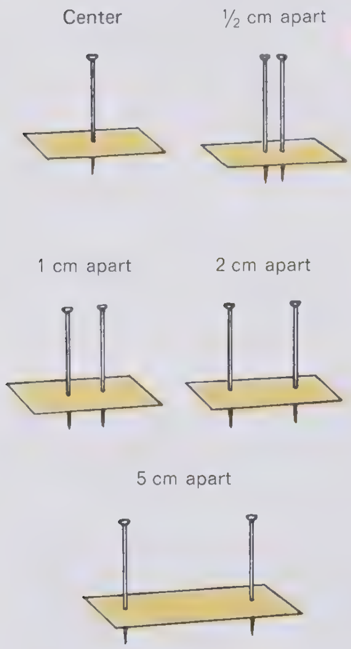
Without eyes and ears, how could Helen achieve as much as she did? How could she keep in touch with the world?

She learned to read by touching raised Braille letters with sensitive fingers. Many blind people read Braille.

B. HOW GOOD IS YOUR TOUCH?

Test yourself in the SENSE-OF-TOUCH ACTIVITY.

SENSE-OF-TOUCH ACTIVITY



A

Push pins through cardboards, like this.

TABLE OF RESPONSES TO TOUCH

Distance between Pin Points	0 Distance	½ cm	1 cm	2 cm	5 cm
Finger tip					
Palm of hand					
Back of hand					
Back of neck					
Inside of forearm					
Outside of forearm					

B

Copy this table.

C

One partner is subject, other partner is tester. Blindfold subject.

D

Tester touches subject's finger tip with the 5 pinboards, one after the other, in mixed up order.

E

Each time, subject says whether he or she feels one pin point or 2 pin points.

TABLE OF RESPONSES TO TOUCH

F

For correct answer, tester checks the box on first line of table. For wrong answer, leave box blank.

G

In the same way, test other areas of skin.

H

Tester and subject change places.

1. How does the activity tell you how sensitive the skin is?
2. Which area of skin is the most sensitive? Explain this result.

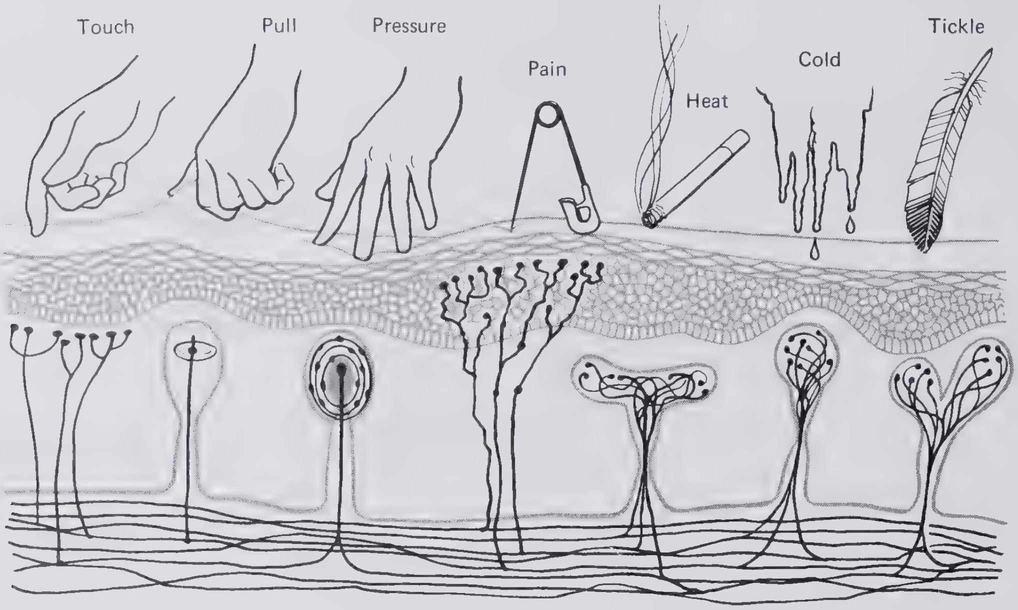
You will also enjoy the touch game.

C. THE TOUCH GAME

1. Each group should secretly pick 20 small objects and hide them in a box.
2. Your group may challenge another group. The captains choose for first up.
3. Each batter in turn is blindfolded. The batter picks an object from the other side's box, feels it, and guesses what it is. A correct guess counts as a run. The batter continues to pick and to guess until he or she misses. One miss puts the batter out.
4. Three misses put the side out.
5. Three innings make a game. The side with the most runs wins.
6. If the objects in a box are used up before the end of the game, time is called. New objects may be added to the box.

D. THE SKIN SENSES

Your skin has other senses besides touch. Tiny nerve endings in the skin are responsible for the various senses.



Can you plan an experiment that will locate the nerve endings for heat and cold? (HINT: Use the SENSE-OF-TOUCH ACTIVITY as a guide.)

9 DRUG SCENE

Junk Mary Jane H Speed Dope Skag Hash Grass
Uppers Downers Acid Goofballs Horse Barbs Dolls Alcohol

Some of these names may not be familiar to you. But many of them are. All are names for drugs.

We live in a drug age, even though we are not all pill poppers. The beginnings of some drug scenes from real life are listed below. Choose a scene that interests your group. First, pick characters and act out the scene for the class. Then, finish the scene.

SCENE A. TRIPS ARE COOL

MOTHER—She has found some different colored pills in her daughter Carla's room. She knows they are drugs. The fact that her daughter may be hooked on dope is going to kill her!

FATHER—He doesn't recognize all the pills. But he knows that some are uppers or **stimulants,** and others are downers or **depressants.** They have just got to make Carla see that **narcotics** can wreck not only her health but also her life.

CARLA—Adults just aren't with it. Trips put her on cloud 9. The world expands. And what's the harm? Her trips are no worse than the pills her mother is always taking, or the coffee and cigarettes her father takes.

Please, leave my things alone!
We love you dear, and we don't want you to harm yourself.

word guide

depressant	*di-PRES-uhnt*
heroin	*HER-oh-uhn*
marijuana	*mar-i-WAH-nuh*
narcotics	*nahr-KOT-iks*
nicotine	*NIK-uh-teen*
stimulant	*STIM-yoo-luhnt*
symptoms	*SIMP-tuhmz*
withdrawal	*with-DRAW-uhl*

SCENE B. MIKE GETS BUSTED

MIKE—I had to mug that old jerk. He won't miss the money. And I had to get some bread for my fix. I have trouble at home and trouble in school. I can't get a job. The fix is the only thing that keeps me going.

MIKE'S LAWYER—This kid is guilty. However, I have to make the best case for him that I can.

MIKE'S MOTHER—My poor boy!

MIKE'S FATHER—I can't do anything with this kid of mine. Maybe if the judge puts him away, they will get him off the habit and straighten him out.

POLICEMAN—I caught this young bum dead to rights. I wonder what kind of story he will tell the judge.

OLD MAN—The boy was probably high when he mugged me. Why do junkies like this make the city unsafe for decent citizens!

JUDGE—My responsibility is to give everyone a fair hearing.

SCENE C. WHAT SHALL WE DO WITH PETE?

PETE—Co-o-ol! What a trip! Man, I'm flying. I'm top dog in the whole world. I can do anything. I stopped the clock. Boy, look at those neon lights!

MONK—This cat sure is high. What are we going to do with him?

JOJO—We have to get Pete out of school before some teacher spots him.

JOSE (wearing SPEED KILLS button)—What a half-wit! When is Pete going to get some sense and go straight. Junk will kill him yet.

DALI, SALVADOR.
THE PERSISTENCE OF MEMORY (PERSISTANCE DE LA MEMOIRE). 1931.
OIL ON CANVAS, 9½" x 13".
COLLECTION, THE MUSEUM OF MODERN ART, NEW YORK.

Is this trip for real?

SCENE D. COLD TURKEY

SUE—I've got a monkey on my back. I know I don't eat right. I can't concentrate on anything. The last time I got an infection from skin-popping, I landed in the hospital. I know I'll OD some day. I wish to heaven I could kick the habit. But I just can't.

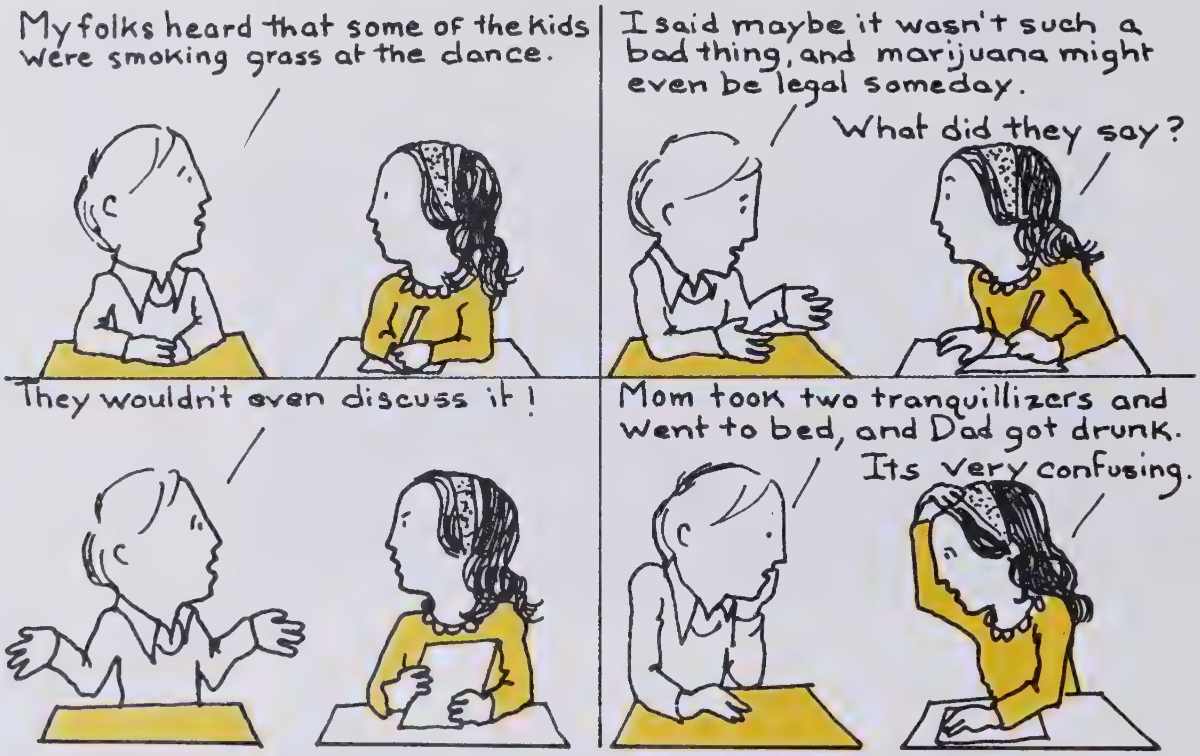
LEE ANN—Poor kid, she's hooked! She knows what horse is doing to her. She ought to shake it. But she probably can't stand the **withdrawal symptoms**—the sweating, cramps, vomiting, fever, runny nose and eyes, and all the rest.

MARTHA—Cold turkey is rough. But **heroin** is rougher. We've got to help Sue.

SCENE E. SHOULD POT BE LEGAL?

JOHNNY—California voted on legalizing **marijuana,** and pot lost. Too bad! Why shouldn't pot be legal? It's no worse than alcohol or **nicotine.** Everyone smokes pot. It isn't fair to bust the few that get caught.

JENNY—I'm glad that pot lost. It's a drug and it's harmful. There is no reason to add that to the list of crutches people lean on. Besides, lots of kids start with reefers and end up on hard drugs.

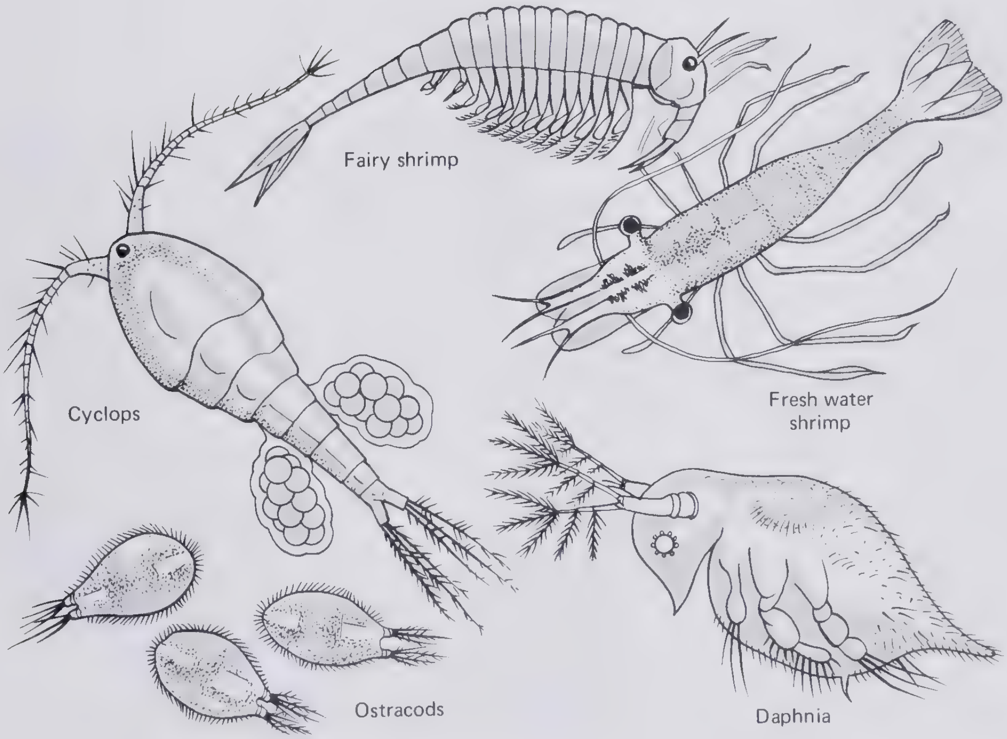

My folks heard that some of the kids were smoking grass at the dance.
I said maybe it wasn't such a bad thing, and marijuana might even be legal someday.
What did they say?
They wouldn't even discuss it!
Mom took two tranquillizers and went to bed, and Dad got drunk.
Its very confusing.

10 DRUGS AND THE WATER FLEA

Swarms of small crustaceans live in the ocean and in fresh water. They are so delicate that you can see right through them.

These tiny creatures are the main food of many fish. Water fleas belong to this group.

Of course water fleas are not really fleas. True fleas are a kind of insect. People buy water fleas to feed their pet tropical fish.

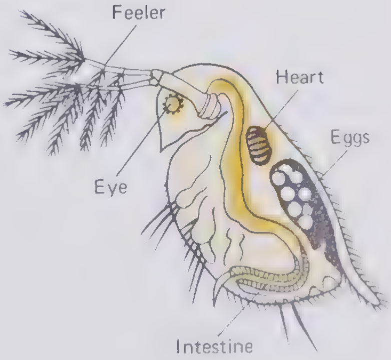


A. THE WATER FLEA

In the WATER FLEA ACTIVITY you will observe the little animal. All the water fleas you see will be females. Males are very scarce.

The female water flea lays eggs all spring and summer. Without being fertilized by a male, these eggs hatch out into more females.

Only in the late fall do the females mate. Then they lay eggs which can produce both males and females.



Daphnia, the water flea

B. STUDYING DRUGS

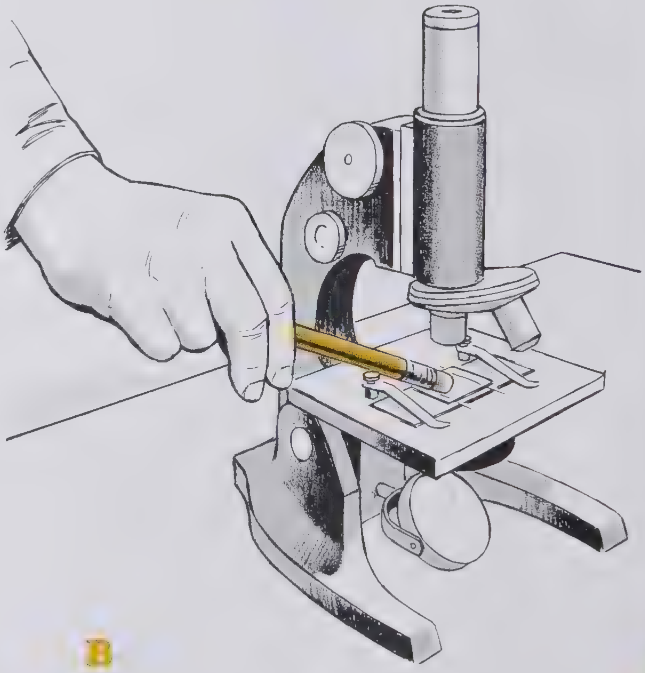
You know that some drugs are stimulants, and others are depressants. Perhaps you don't believe that drugs really change the body.

In the WATER FLEA ACTIVITY you can measure the effect of drugs on the water flea's heart. The drugs have the same effect on your heart.

WATER FLEA ACTIVITY

A

Transfer your water flea to a slide. Add a cover slip supported by nylon bristles. Examine with the microscope.



B

Find the shell. Find the eggs. If you gently press on the cover slip, you can squeeze some eggs out of their pouch.

1. Describe the water flea and its shell.

C

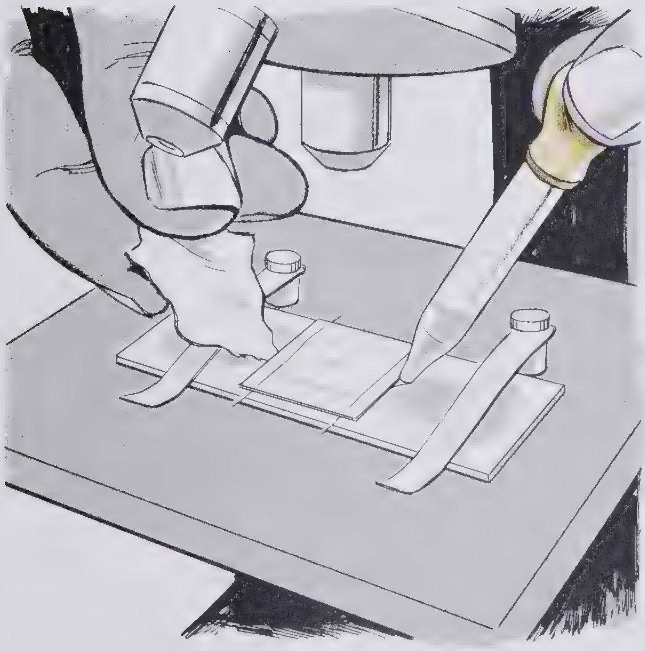
Find the feelers.

2. How many feelers are there? What do you think they do?

D

The water flea has one large eye. Watch it. Use the microscope diaphragm to change the brightness of the light, slowly, several times. The water flea's response will surprise you.

3. What is the response?



E

Feed your water flea. Use a paper towel to draw the food under the cover slip.

4. How does the water flea eat?

F

The 5 pairs of legs help in respiration. They send water to the gills. Add colored water and watch the legs at work.

5. How does the working of the legs help the gills?

G

Locate the beating heart. Count the heart rate for 30 seconds. Tap on a sheet of paper in time with the heartbeat, while your partner watches the clock. Then count the pencil marks. Multiply by 2 to get the rate per minute.

6. What is the normal heart rate?

H

Add stimulant and depressant drugs, one at a time. For each, measure the heart rate. Remove each drug. Wash off the water flea with a dropper before adding the next drug.

EFFECT OF DRUGS ON WATER FLEA HEART

Drug	Heart Rate per Minute	Stimulant or Depressant

I

Record results in a table like this.

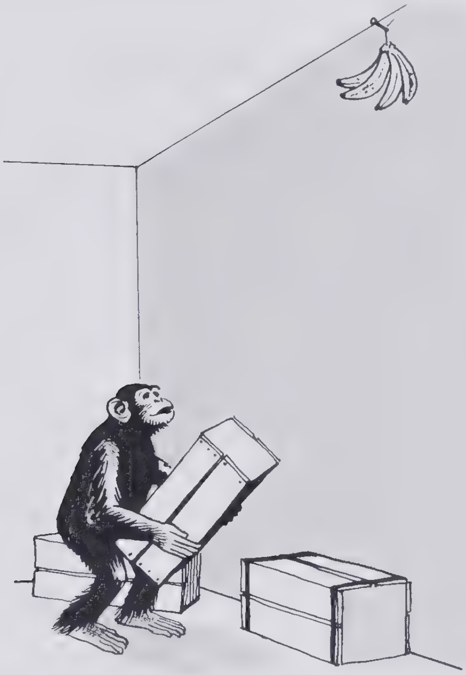
7. Which drugs are stimulants?
8. Which are depressants?

11 BANANAS AND CARD GAMES

word guide

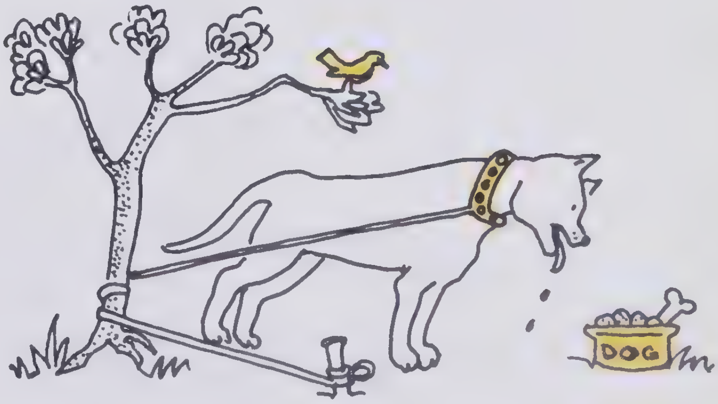
intelligent
in-TEL-uh-juhnt
tumor
TOO-muhr
unconsciously
un-KON-shuhs-lee

The chimpanzee wanted the banana. The problem was how to reach it. You can see how the chimp solved the problem.



A. DO ANIMALS THINK?

Clearly the chimpanzee has some thinking ability.



The dog wasn't as successful in solving its problem. Dogs don't think as well as chimpanzees.

Probably many animals think in very, very simple ways. Certainly the more **intelligent** animals have pretty good thinking ability. But none of them thinks as well as we do.

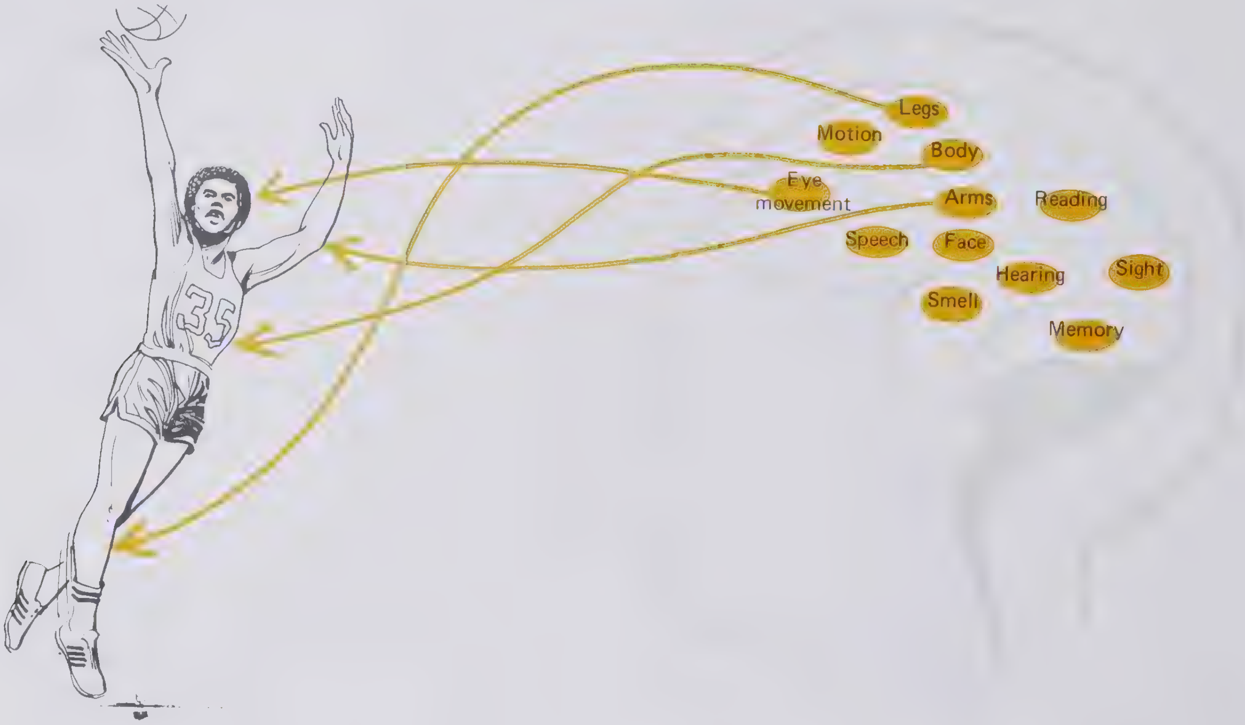
B. THE THINKING MACHINE

We think with our brain. The brain also controls our body. There is evidence to support these statements.

Parts of the brain are sometimes damaged by injuries, **tumors,** or bursting blood vessels. Certain abilities are then lost. For example, a blow that damages the back of the brain may cause blindness, even though the eyes are still in perfect condition.

The rebounding basketball player isn't an automatic man. He doesn't depend just on reflexes. He thinks—very fast—about every move he makes.

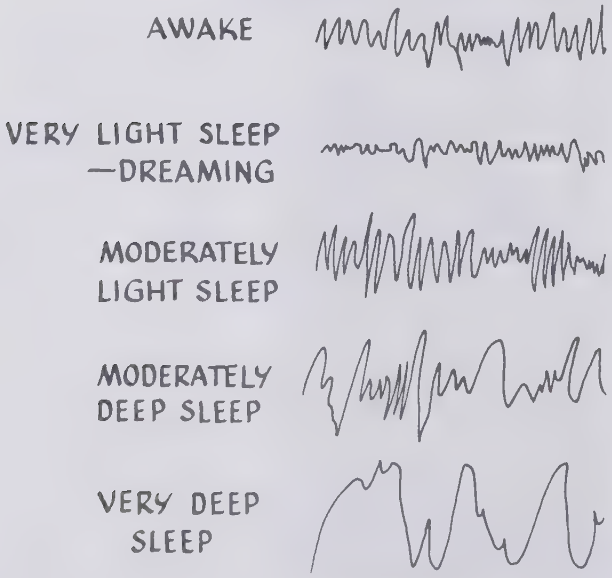
The map shows the parts of his brain that control certain parts of his body. Suppose the part of the brain that controls his arms is damaged. The arms will get no messages. They won't work. And there will be no more basketball for this player.



C. BRAIN WAVES

When brain cells are active, they produce electricity. An EEG or brain wave machine records the electricity. Specially trained technicians run the EEG machine.

You can see the difference in brain waves when a person is dreaming, and when he or she is sleeping very heavily. Thinking also shows up in the brain waves.



ALBERT C. FLORES, PIX INCORPORATED

EEG machine traces brain activity

D. REASONING

Shooting a basket is tricky. But the thinking that it requires is fairly simple. A more complicated kind of thinking is called reasoning.

You reason in several different ways. One way to reason is to apply a general rule. Your rule may be that seniors know more than sophomores. Then you will tend to believe a senior rather than a sophomore.

In another kind of reasoning, you don't make up a general rule until you have seen a number of examples. When the class gets a new teacher, the kids try to test the teacher. Suppose you find that she or he handles every situation very well. Then you reason from these examples: This teacher is cool; better do what the teacher says!

Scientists depend a lot on this second kind of reasoning. Of course you can go wrong with either kind. Not every senior knows more than every sophomore!

E. WHEN LIGHTNING STRIKES

Have you ever racked your brain about a problem and not been able to solve it? Then suddenly, like a bolt of lightning, the solution hits you.

You've got it!

This kind of thinking is sometimes called insight. What probably happened was that you were slowly and **unconsciously** putting 2 and 2 together, until you arrived at the answer.

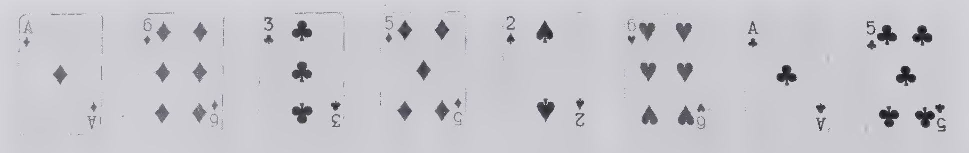
When you are stumped by a problem, it may be helpful to put it aside for the time being. Sleep on it. Give the unconscious part of your mind a chance to work on it. In the morning the solution may come easily.

F. GUESS-THE-PATTERN GAME

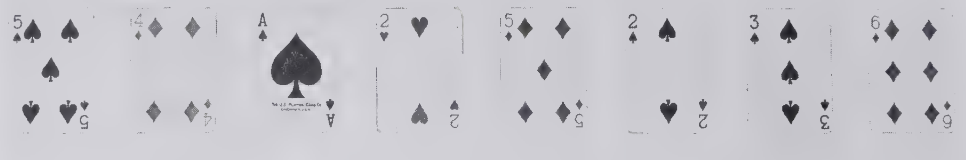
Many card games require reasoning. Here are the rules for an interesting game:

a. Two may play. One is the dealer, the other the player.
b. From a regular deck of cards, use only the aces, 2's, 3's, 4's, 5's, and 6's.
c. Without letting the player see them, the dealer arranges the 24 cards in the deck in some regular pattern, like these examples:

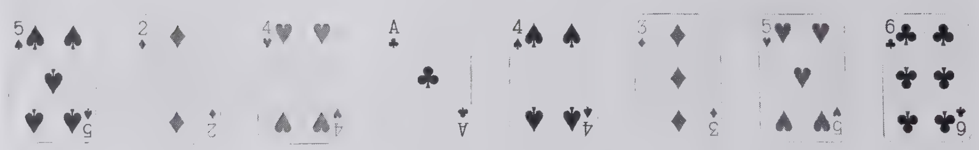
Alternating low and high



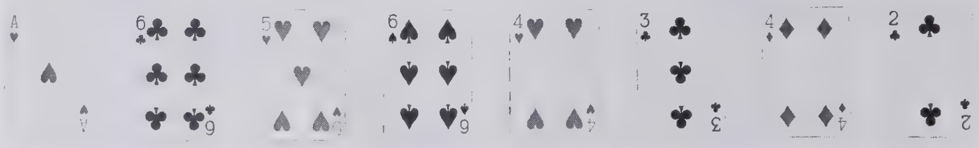
Alternating odd and even



Alternating suits



Alternating red and black



d. Arrange cards in only one pattern. A no-no would be a suit-and-number pattern, or a number-and-color pattern.
e. The aim of the game is to guess the pattern.
f. The dealer lays out the cards face up one at a time. After each card, the player may take one guess, or pass.
g. The dealer answers either yes or no to each guess.
h. When the player correctly guesses the pattern, his or her score is the number of cards left in the dealer's pack.
i. At the end of the game, player and dealer switch.
j. After a given number of games, the player with the highest point total wins.

1. What kinds of reasoning or thinking did you use in playing Guess-the-Pattern?
2. Explain the title of this chapter.

12 HOW WE LEARN

word guide

conditioning
kuhn-DISH-uhn-ing
motivated
MOH-tuh-vay-tuhd
Pavlov
PAHV-luf

Some kids say they don't like to learn.

How wrong can they be!

We learn all through life. Everybody likes to learn. Learning can be more fun than a picnic.

"Prove it," you will say. All right, let's prove it.

Are these kids hurting?

A. WHAT WE LEARN

Learning begins long before we start school.

A baby learns to recognize its parents. It learns to crawl, to walk, to eat, to control its bowel movements, to talk. Later the child learns to dress itself, to tie its shoelaces, to find its way home. These things are more basic than anything we learn in school or in later life.

We learn to play games and sports, to drive a car, to stay out of danger, to get along with people, to handle a job. We mainly learn these things outside of school. We learn them because we want to learn them.

Who says we don't like to learn?

B. LEARNING IN SCHOOL

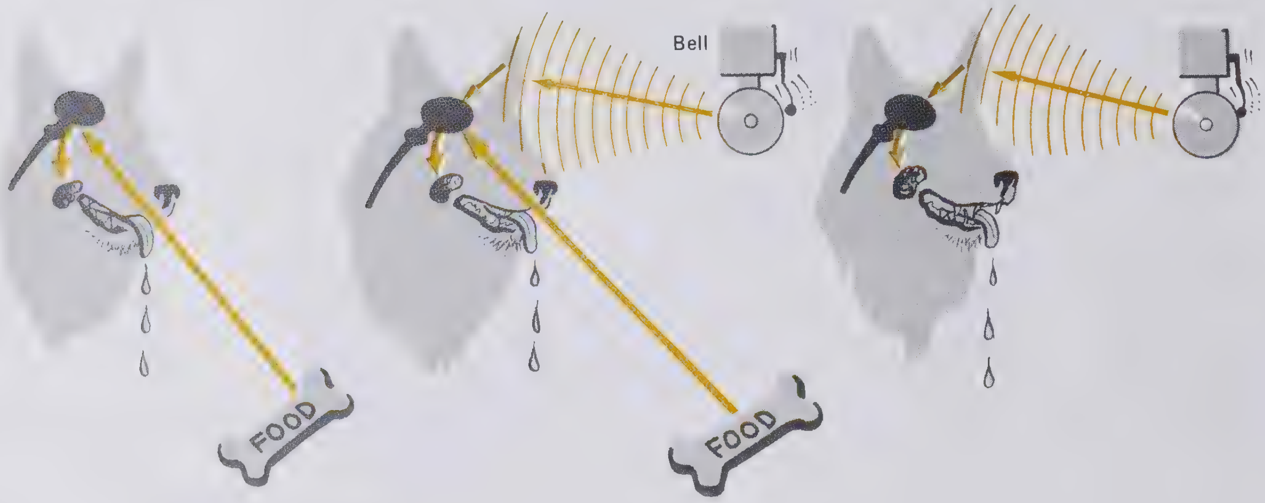
Schools are set up to teach some important special things. Most vital are reading and writing. It is hard to get along in the modern world without these skills.

Math, science, social studies, art, English, business, and health education are other school subjects. It's important that we understand them. They introduce us to many of the things that went on long before we were born, and that will continue long after we die.

1. What are you learning in this biology class that is useful to you?

C. THE DOGS THAT LEARNED

Ivan **Pavlov** was a Russian psychologist. He experimented with dogs. Whenever one of his dogs was fed, its saliva flowed. Pavlov rang a bell each time he brought food. Pretty soon the bell alone made the saliva flow. The dog had learned to respond to the bell as well as to the food.



Learning to respond to a new stimulus is called **conditioning.**

2. How were Pavlov's dogs conditioned?
3. Can you give some ways in which your responses have been conditioned?

D. HOW WE LEARN

In all learning, our responses are changed. Conditioning is one form of learning. There are other forms.

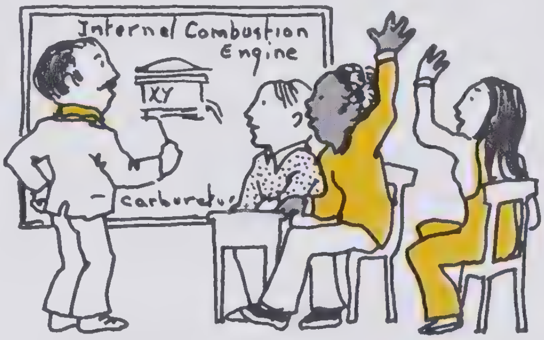
Suppose you have a bunch of keys. You don't know which one unlocks a door that you have to open. By trying the keys one after the other, you find the right one. This is an example of trial-and-error learning.

4. Why is the example called trial-and-error learning?

If you want to learn to sink baskets, you practice for hours. Practice helps learning.

Understanding a subject helps you learn it. It also helps if you are interested or **motivated.**

When you succeed in a subject, the pleasure and satisfaction you get help you learn it. One reason you probably like this course is that you can succeed in it. Who said learning can't be fun!



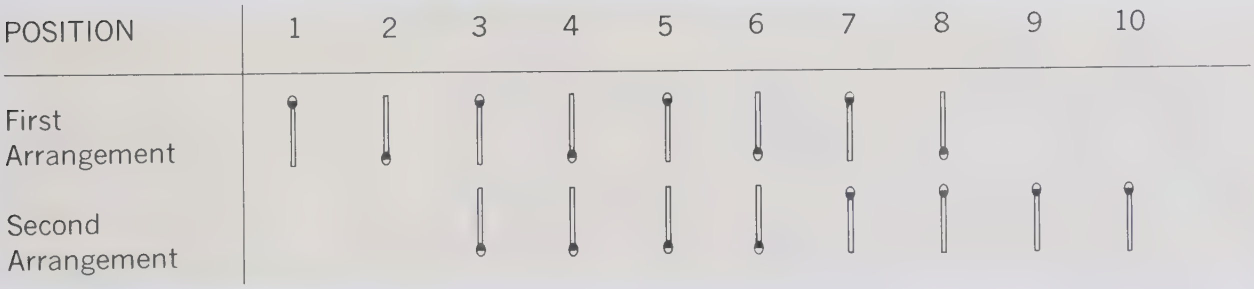
In the BRAIN-TEASER ACTIVITY you can test some learning methods.

BRAIN-TEASER ACTIVITY

THE MATCH PUZZLE

A

Work with a partner. One partner is the timer. The other is the subject.



B

Line up 8 matches as in first arrangement. By moving 2 neighboring matches at a time, subject changes matches to second arrangement. Start when timer says, "Go."

C

Copy this chart. Timer records how long subject took to do puzzle.

THE MATCH PUZZLE

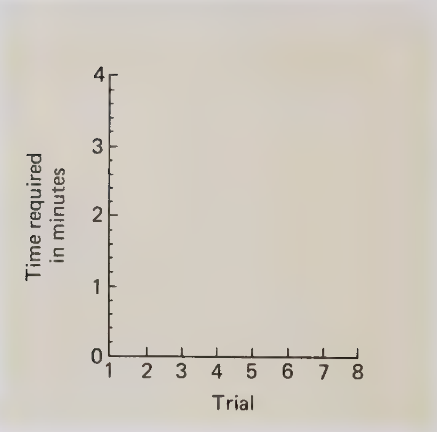
Trial No.	Time Required
1	

D

Replace matches, and repeat. Subject keeps repeating until 2 trials take the same length of time.

E

Timer and subject switch.



F

Make a graph of each partner's results. The graph is called a learning curve.

5. What did your learning curve tell you?

6. Which forms of learning did you apply in solving the match puzzle?

G

Read this list of nonsense words 5 times.

LOONY LIST

ZOP
MAG
DUR
MIN
WUG
NID
FUD
BUL
TIG
LAT

H

Close your book. Write down all the words you can remember, in any order.

I

Check your list against the book.

7. How many words did you remember?

J

Repeat for this list.

Ball
Hold
School
Eat
Rock
Man
Mother
Walk
Butter
House

8. How many words did you remember?

K

Repeat for this list.

There
are
more
than
nine
ways
to
skin
a
cat

9. How many words did you remember?

10. Explain the differences in your scores in memorizing the 3 lists.

13 ESP

"Guess what I'm thinking!"

Maybe you have said this a dozen times to your friends. Maybe some of the times your friends did guess what you were thinking.

Perhaps it was just luck. Or perhaps your friends guessed right because they know you so well; they know the way you think. That's what some people would say.

word guide

extrasensory	*ek-struh-SEN-suh-ree*
migrate	*MY-grayt*

A. EXTRASENSORY PERCEPTION

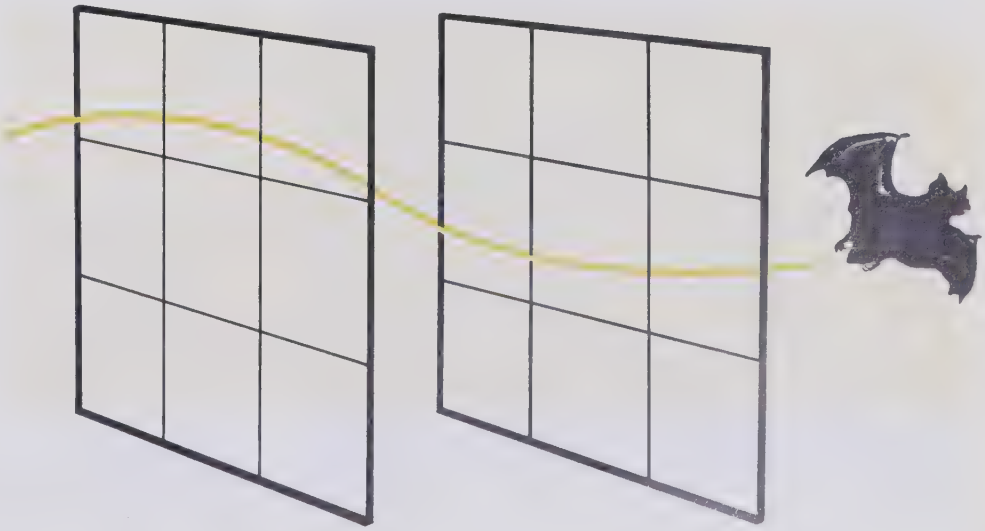
Others say that there are people who can read your mind, tell what's hidden behind a door, tell which card is turned up without seeing it, and even foretell the future.

These strange abilities, if they exist, are called **extrasensory perception** (ESP). Some think that ESP works without using the senses. Some think that people with ESP just have better developed senses than the rest of us.

B. THE ANIMAL SENSES

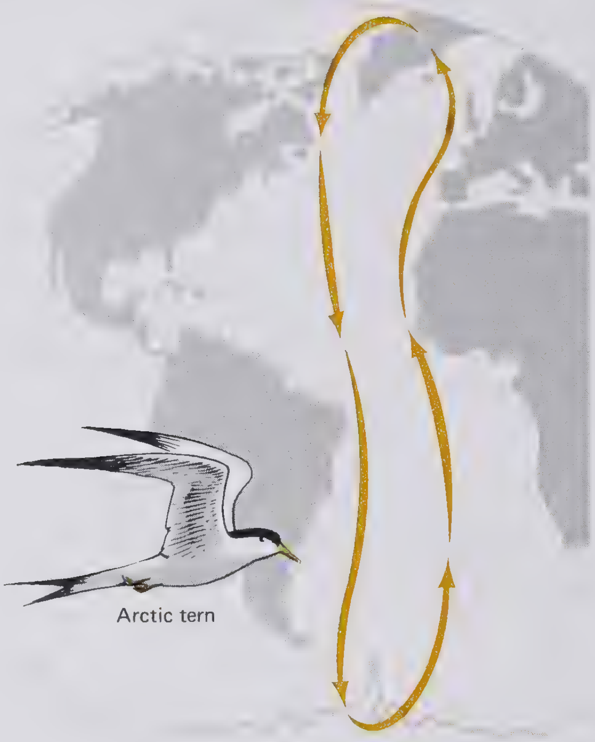
It is true that many animals have better developed senses than people. For example, in dim light, cats see better than humans.

Animals also have some senses that we don't possess at all. In complete darkness, bats can catch insects and avoid obstacles. The bats make clicking sounds as they fly. The sounds bounce back and tell the bats what is around them.



This is a kind of radar. Airplanes and ships use it, but the bats had it first.

Many birds **migrate** long distances. Some birds spend half the year far north in the Arctic, and the other half year near the South Pole. The flight is thousands of miles long. We don't know how the birds find their way.



Do some people also have senses that the rest of us don't have?

DR. J. B. RHINE–THE INSTITUTE FOR PARAPSYCHOLOGY

C. TESTING ESP

At Duke University, Dr. J. B. Rhine has a laboratory that experiments with ESP. Rhine reports that some of his subjects are very sensitive. He thinks they have ESP.

Many scientists don't agree with Rhine. They say a successful ESP experiment may just be luck. The same experiment has to be repeated many times by different people before it becomes convincing.

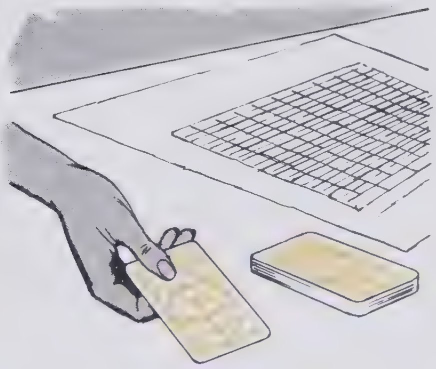
Student in Rhine's laboratory guessing which light bulb will turn on

In the ESP ACTIVITY, you can do one of Rhine's experiments. Remember that it doesn't prove anything until you repeat it many, many times and get the same results.

ESP ACTIVITY

A

From a deck of cards, tester takes 5 cards from each suit, shuffles the 20 cards, and lays them face down.



B

Tester removes the top card. Without looking at it, lays it face down beside the deck.

C

Subject guesses suit of this first card.

D

Tester records the guess in a table like this.

TABLE OF GUESSES AND ACTUAL CARDS

	TEST 1		TEST 2		TEST 3		TEST 4		TEST 5	
	Guess	Actual	Guess	Actual	Guess	Actual	Guess	Actual	Guess	Actual
1										
2										
3										
↓										
20										
Score										

Total Score ____________

Key: C = clubs D = diamonds H = hearts S = spades

E

Repeat for remaining 19 cards. Tester moves cards one at a time from deck. Piles them on first card without looking at them.

F

After subject has made 20 guesses, tester turns discard deck over. Tester records actual order of cards.

G

Tester checks to see where "guess" and "actual" are the same. The score is the number of correct guesses.

H

Repeat ESP test 4 or more times. Add up individual scores to get a total score.

I

By pure chance, subject should on the average guess right 25 times out of a hundred. The table gives odds against doing better or worse than this.

ODDS AGAINST GUESSING CARDS CORRECTLY

No. of Tries	Correct Guesses by Pure Chance	Better Than Chance Scores		Poorer Than Chance Scores	
		Good Scores (20:1 Odds Against Them)	Excellent Scores (100:1 Odds Against Them)	Poor Scores (20:1 Odds Against Them)	Very Poor Scores (100:1 Odds Against Them)
100	25	34	36	16	14
200	50	62	65	38	35
300	75	90	93	60	57

1. Did you get any scores that seem to show you have ESP?
2. Could the results depend just on luck?
3. Could you change the experiment to see if the subject can read the tester's mind instead of reading the cards?

14 FACES, FACES

You know that people do things by reflex. We have sensations. We think. We learn. We also feel **emotions.** We feel sad, angry, happy, kindly, frightened, friendly.

word guide

emotion	*i-MOH-shuhn*

He's cute.
Show off!
He'll hurt himself
Dynamite!

A. OUR FACE, OUR EMOTIONS

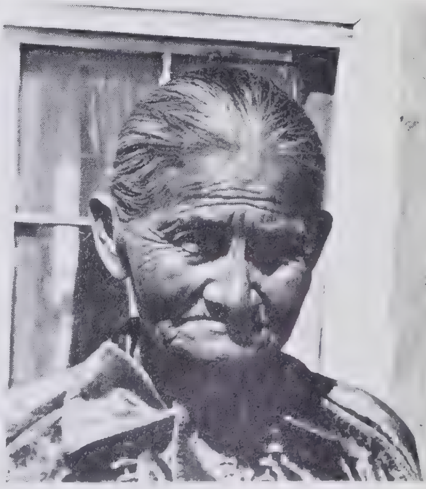
Emotions show in our body, especially in our face.

Beneath the skin are muscles. Emotions make the muscles tighten or relax.

Have you ever noticed how an angry person seems to stiffen? The stiffening is a kind of body language. It is a way of saying, "I am angry."

There is also a face language. Moving the muscles of your face wrinkles the skin. The wrinkles give you expression. By watching your face, people can tell your emotions.

In time the wrinkles deepen and become permanent. A person's life shows in his or her face.



B. RELEASING EMOTIONS

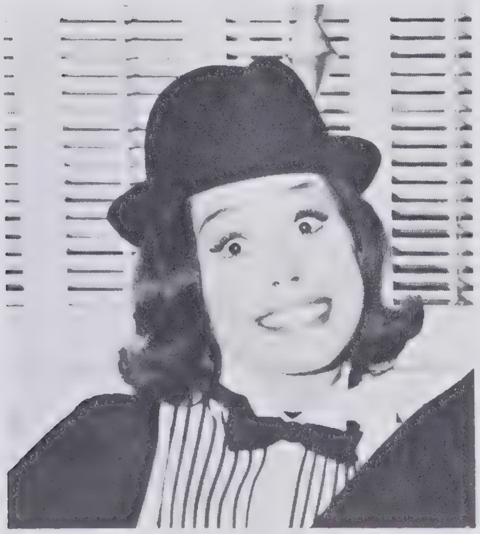
People may try to hide emotions, and not let them show in their bodies and their faces. This is a poor idea. Hidden emotions may "eat you up inside."

It is usually better to show your emotions, to talk things out, to let off steam.

People with emotional problems may visit a psychologist. In many ways the psychologist can help people learn to release their emotions. First the problem is discussed.

Then the psychologist may let a child visitor "make faces." Adults may be told to act out how they feel.

Psychologist counseling a student



MOVIE STAR NEWS

C. ACTING IT OUT

In a play you can act out the emotions that you really feel.

Or you can imitate emotions. This is what actresses and actors do.

Mary Tyler Moore knows how to make faces, use her body, and put on makeup. These skills help her to show emotions she doesn't really feel.

How does she do this? Does she make her eyes look different? How about her hair, her eyebrows, her forehead, her mouth, her cheeks?

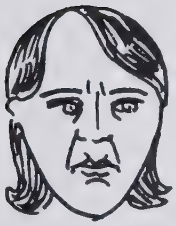
The FACES WORKSHEET will help you understand how actors and actresses show different expressions and emotions.

Faces Worksheet

Look at the different expressions and emotions shown in the pictures. They are all pictures of the same person. Notice how the person's appearance changes.

Then look at the list of words which describe the expressions and emotions.

A



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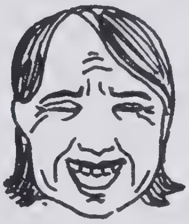

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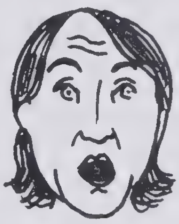

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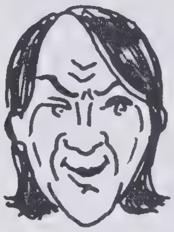

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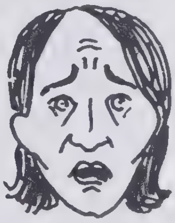

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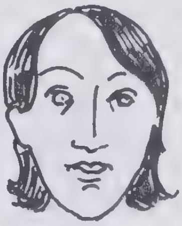

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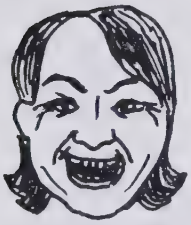

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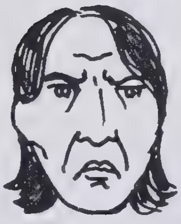

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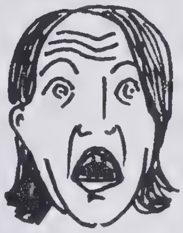

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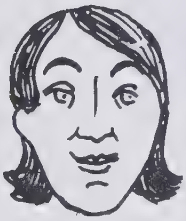

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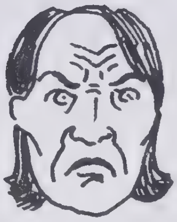

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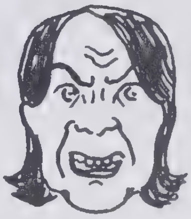

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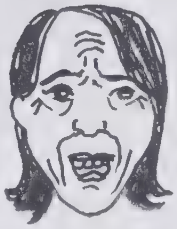

LIST OF WORDS WHICH DESCRIBE THE EXPRESSIONS

angry
relaxed
sad
surprised
grief stricken
frightened
criminal
in pain
smiling
kind
thoughtful
evil
enraged

Copy the following chart and match each face with the word from the list that best describes the expression or emotion. The first example is already done for you.

Face	Expression
a	thoughtful
b	
c	
d	
e	
f	
g	

Face	Expression
h	
i	
j	
k	
l	
m	

D. MAKING FACES

In the MAKING-FACES ACTIVITY you can test your own ability to create expressions and imitate emotions.

MAKING-FACES ACTIVITY

Boy, You sure can look ugly!

A

Look at a mirror or at your partner. Make a face like one of the expressions on the WORKSHEET. Try to figure out how you imitated the expression.

The makeup makes you look a hundred years old!

B

Make up your face to give it a new expression or to imitate an emotion. With other made-up students, act out the emotion.

Would you believe he is the president of a bank?
WANTED $5000

C

Cut out a face from a newspaper or magazine. Paste it on a sheet of paper. Draw lines, beards, or other features on the picture to change the expression.

1. What kind of person did you see in the cut-out picture?
2. What kind of person did you change the picture to show?

D

Add your picture to the class exhibit.

15 MOONWALK

During the Apollo missions, **astronauts** explored the moon.

word guide

astronaut	*AS-truh-nawt*
inflatable	*in-FLAYT-uh-buhl*
solar	*SOH-luhr*
transmitter	*trans-MIT-uhr*

A. NO LIFE ON THE MOON

The explorers found no signs of life there. The moondust they brought back didn't even contain germs.

The moon has no air or water. This is only one of the problems the astronauts had to be prepared for.

The Apollo missions have ended. But during your lifetime, other space missions will leave the earth. Some future astronauts are now in high school.

NASA

Man on the moon

WIDE WORLD PHOTOS

Soviet cosmonaut
Valentina Tereshkova

B. PROBLEMS IN SPACE

As in the past, astronauts of the future will face dangers and difficulties. To survive, the astronauts will have to play it cool.

The LOST-ON-THE-MOON WORKSHEET gives you a chance to tackle a space problem of the future. The WORKSHEET is on the next page. DO NOT TURN THE PAGE YET. First do the LOST-ON-THE-MOON ACTIVITY.

LOST-ON-THE-MOON ACTIVITY

A

Volunteers will be chosen to form a team of astronauts. The team should wait outside the classroom. When they are called back to class, they will be given their space problem.

B

When the volunteers have left, the other students may turn to the LOST-ON-THE-MOON WORKSHEET.

LOST-ON-THE-MOON WORKSHEET

You are lost on the moon with a small team of astronauts. The spaceship that brought you is resting on the surface. It will blast off when you get back from your exploring trip.

But you are at least 200 kilometers (120 miles) from the spaceship. Your moon buggy has broken down and you can't repair it. You and the others will have to walk back.

Your space suits are in good shape. The wrecked moon buggy is stocked with supplies and equipment. But you cannot carry them all. Which items will you take?

The available items are listed below. Copy the list and place number 1 by the item which you think is most important. Place number 2 by the next most important item, and so on to number 12 for the least important. While doing this, consider what you know about conditions on the moon. When you have numbered your list, discuss it with others in your group. Agree on a group list.

LIST OF AVAILABLE ITEMS

________ 20 meters (66 feet) of nylon rope
________ Box of matches
________ Concentrated food
________ 2 25-kilogram (55-pound) tanks of oxygen
________ **Solar**-powered heater
________ Loaded pistol
________ First aid kit
________ Signal flares
________ Can of water
________ Star map
________ **Inflatable** life raft
________ Radio receiver and **transmitter**

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CHILDREN AND ANCESTORS

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CHILDREN AND ANCESTORS

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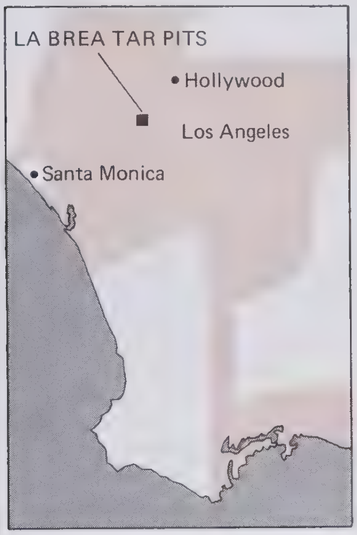
1 FOSSILS AND OIL WELLS

This tarpit is in La Brea Park, in Los Angeles. The tar slowly bubbles. Insects and leaves fall into the tar and are preserved.

word guide

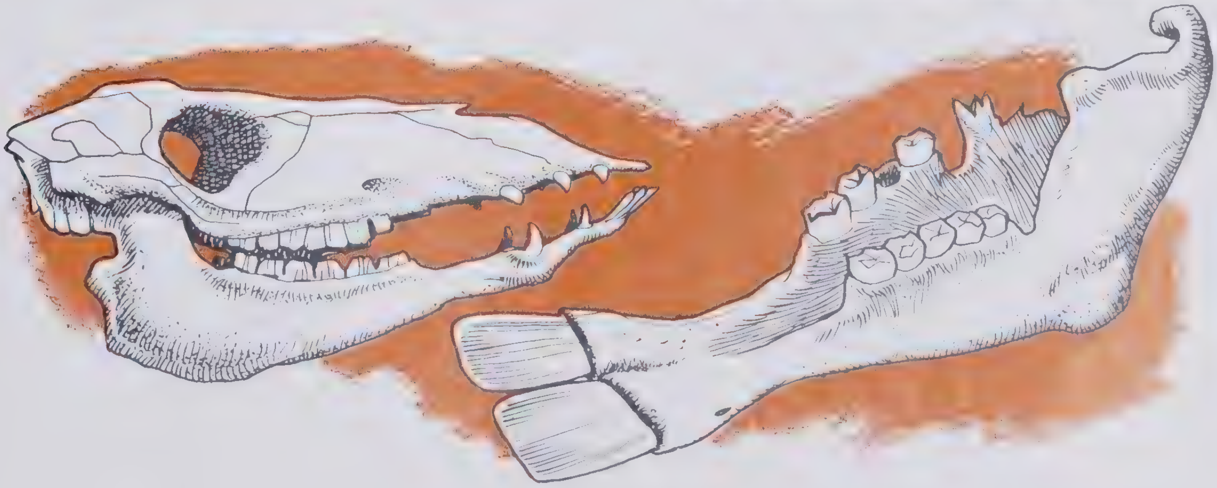
dinosaur	*DY-nuh-sawr*
fossils	*FOS-uhlz*
geologist	*jee-OL-uh-jist*
refineries	*ree-FYN-er-eez*



Nearby is another tarpit, an old dried-up one. It dried up a million years ago.

LOS ANGELES COUNTY MUSEUM OF NATURAL HISTORY

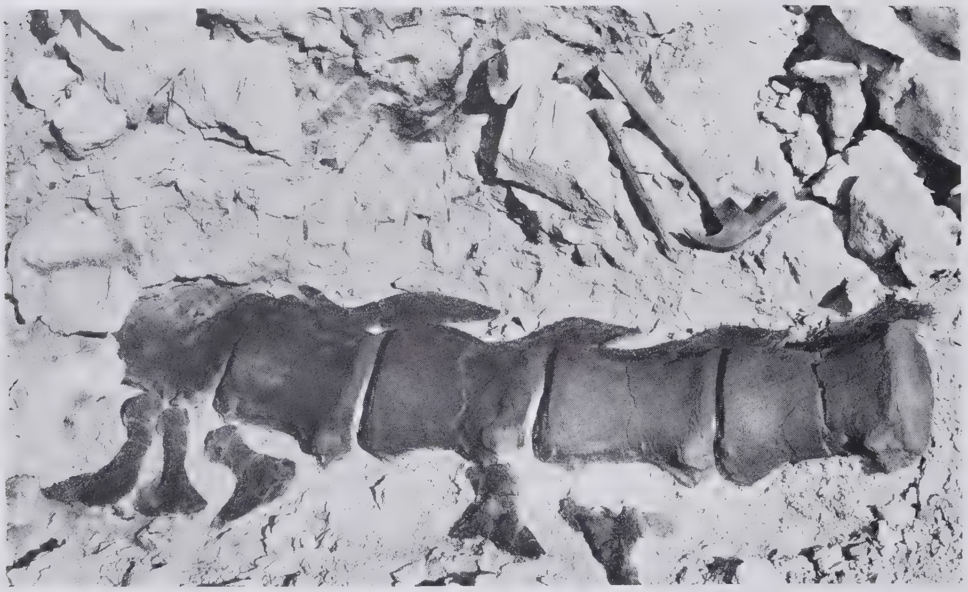
Below are pictures of things that were dug out of the dried-up tarpit. They look as though they were once part of living animals. They are **fossils.**



A. WHAT'S A FOSSIL?

A fossil is the remains or record of an ancient living thing.

Fossils are found in dried-up tar. More often they are found in rocks, like these rocks from Wyoming.



COURTESY AMERICAN MUSEUM OF NATURAL HISTORY

How did the fossils get into the rocks? You can find out by making an imitation fossil in the MAKING-A-FOSSIL ACTIVITY.

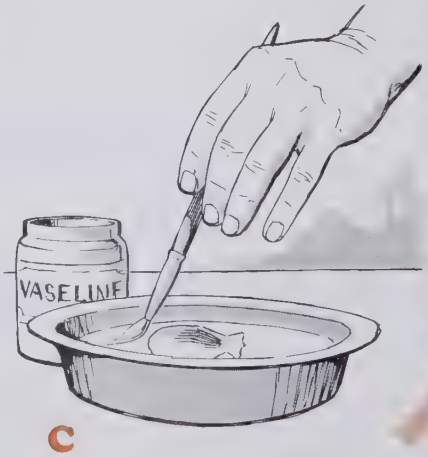
MAKING-A-FOSSIL ACTIVITY

A

Mix plaster of Paris in a dish.

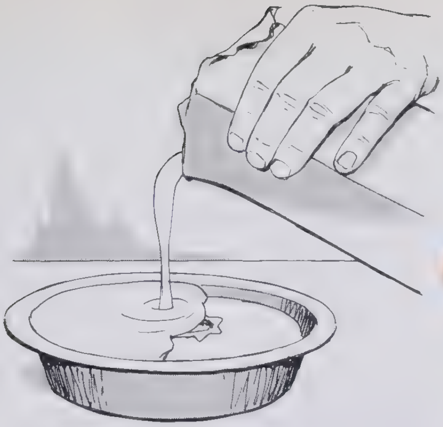
B

Press shell, leaf, or bone into plaster. Let it dry.



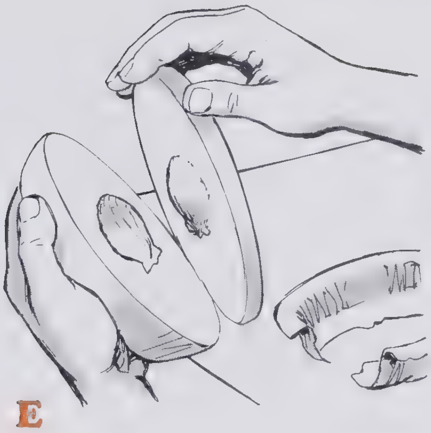
C

Cover surface with thin coat of vaseline.



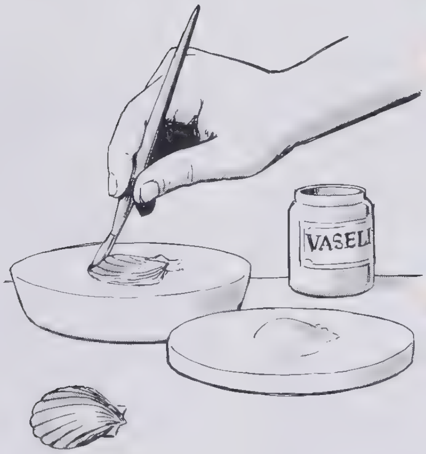
D

Add more plaster. Let it dry.



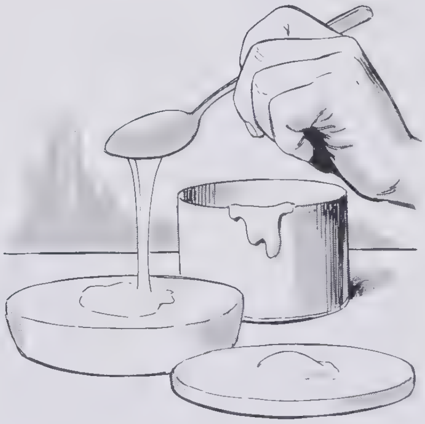
E

Break open. Remove shell or other object. A mold is one kind of fossil.



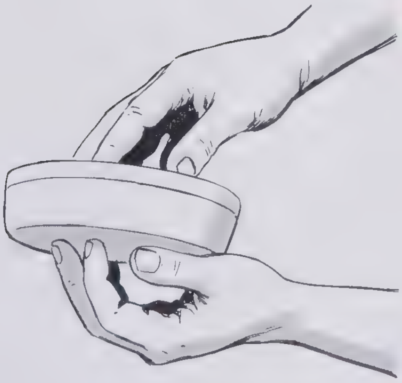
F

Line mold with thin coat of vaseline.



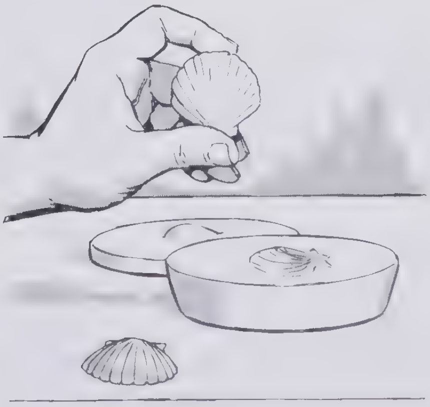
G

Fill mold with plaster.



H

Press halves of mold together. Let dry.



I

Open mold. Remove cast. This is another kind of fossil.

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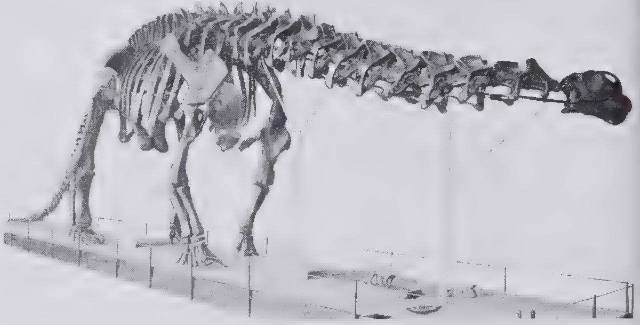
© HANNA-BARBERA PRODS. INC.

B. DINO THE DINOSAUR

Dino the **Dinosaur** is a character in The Flintstones. Dinosaurs are animals that lived about 200 million years ago.



COURTESY AMERICAN MUSEUM OF NATURAL HISTORY

Nobody has ever seen a live dinosaur. However, the Wyoming rocks contain lots of dinosaur fossils.

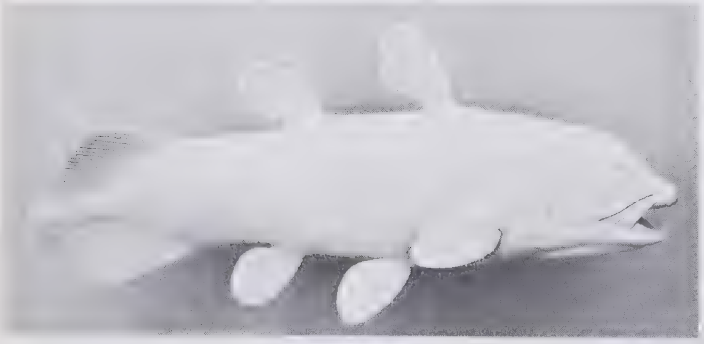
In a museum you can see the bones of a dinosaur that lived long ago. The dinosaur was reconstructed from fossils dug out of rocks.

Scientist Barnun Brown digs out Texas fossil

Chipping a fossil skull out of the rock

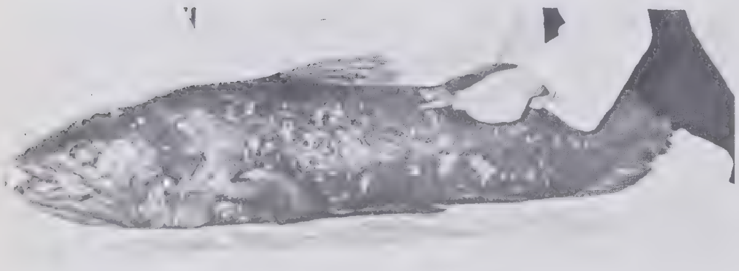
Years later, in the lab, Dr. Brown reconstructs fossil dinosaur

COURTESY AMERICAN MUSEUM OF NATURAL HISTORY



COURTESY AMERICAN MUSEUM OF NATURAL HISTORY

Reconstruction of ancient lobe-fin



PAUL POPPER LTD

Fresh-caught modern lobe-fin

C. THE FISH THAT CAME ALIVE

People wonder if scientists' reconstructions of fossils are accurate. Let's see what the evidence shows.

The lobe-fin fish was reconstructed from bone and skin fossils that were 180 million years old. Nobody had ever seen a living lobe-fin. Scientists thought these fish had died out ages ago.

Then in 1938 some African trawlers caught a strange fish in the ocean. It was a lobe-fin.

Compare the reconstructed fossil with the actual fish caught by the Africans.

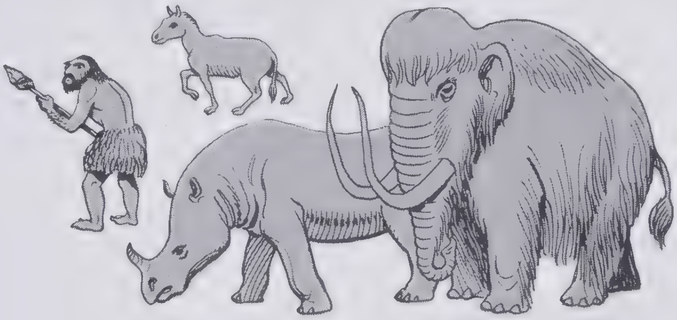
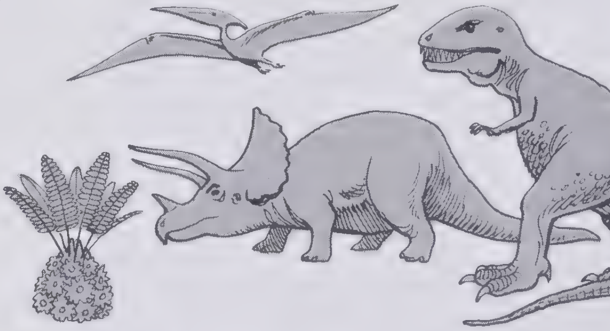
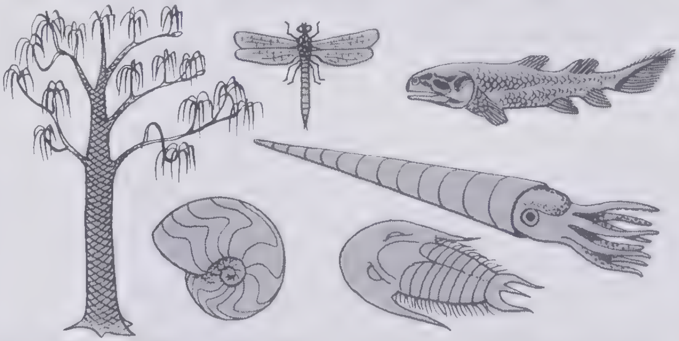
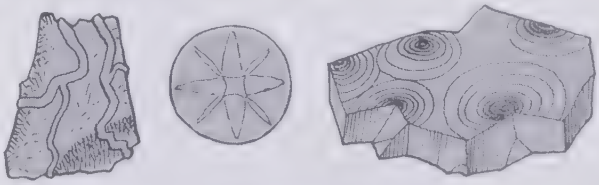
1. Did the scientists accurately reconstruct the fossil lobe-fin? Explain.

D. FOSSILS ARE TATTLE-TALES

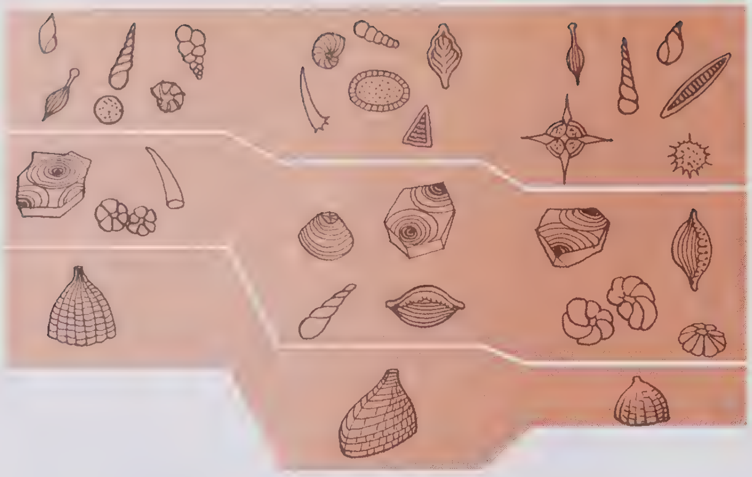
How old are fossils?

Study the diagram below. Notice that the rock layers are of different ages. And each layer has different kinds of fossils.

FORMS OF FOSSILS FOUND IN VARIOUS ROCK LAYERS

Rock Layers	Age	Fossils
Recent layers	1 to 70 million years ago	
Middle layers	70 to 200 million years ago	
Old layers	200 to 500 million years ago	
Ancient layers	500 million to $2\frac{1}{2}$ billion years ago	

2. Which layer has fossils that are most familiar to you?
3. Which layer has dinosaur fossils?



Many fossils are useful. Some microscopic fossils help prospectors find oil. These tiny fossils are generally found in certain layers of rock near oil.

In searching for oil, the prospector sinks a test well. The drill brings up samples of rock. Fossils in the rock may tell the prospector if there is oil nearby.

4. How do fossils help the prospector decide what to do about the well?

Puerto Rican oil refinery

PUERTO RICO NEWS SERVICE

E. BE A ROUGHNECK

Oil is a big industry. The people who work in the oilfields are called roughnecks.

In **refineries** the oil is made into gasoline. Mechanics work in refineries. The oil industry also needs **geologists,** engineers, accountants, secretaries, truck drivers, and men and women in hundreds of other trades and professions.

MICHAL HERON, MONKMEYER PRESS PHOTO SERVICE

F. OR RUN A GAS STATION

The largest number of people in the oil industry work in gas stations. An operator may own the gas station. But often the operator rents the station from an oil company.

Nobody begins by running a gas station. A boy or girl can start by working as a helper, filling gas tanks, checking oil and tires, and doing odd jobs. A helper who learns enough can qualify as a manager.

The gas station operator may not know it, but the fossils that guided the oil prospector helped put the gas station in business.

5. Write a sentence about each of these terms: fossil, dinosaur, roughneck (as a trade).

2 CHANGING HORSES

word guide
bronco
BRONG-koh
eohippus
ee-oh-HIP-uhs
evolution
ev-uh-LOO-shuhn
mustang
MUS-tang
palomino
pal-uh-MEE-noh
thoroughbred
THUR-uh-bred

Horse-drawn wagons used to be common. Have you ever seen one? Cars and trucks have replaced horse-drawn wagons.

This work horse lives on a farm. It used to pull farm machinery. Now it is retired, replaced by a tractor. The horse's only work is to give the children a ride.

Jobs with horses have changed. The breeds of horses that we use have also changed. But horses aren't outdated. People like them. Horses still provide people with pleasure and jobs.

A. RACE HORSES

The horses that run at race tracks are called **thoroughbreds.** Thoroughbreds are easily frightened. The jockey who rides one has to like horses and be able to handle them. The jockey must be strong and weigh less than 64 kg (140 lbs).

Jorge Velasquez is a leading jockey. He is tough. He started as an exercise boy.

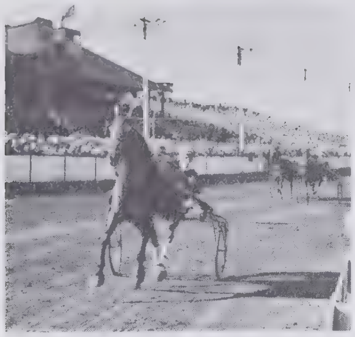
WIDE WORLD PHOTOS, INC

Answer the following questions. See who can produce the longest lists in 10 minutes.

1. How many modern uses of horses can you name?
2. How many jobs connected with horses can you name?

B. HORSE FAIR

There are many kinds of horses. Each kind is bred for a special purpose. Here are some of the breeds.



NATIONAL FILM BOARD PHOTO, CANADA

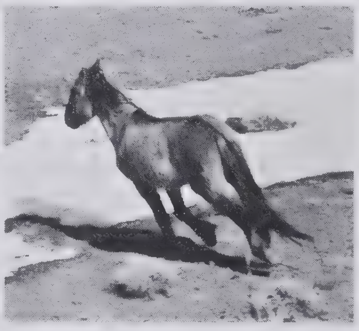
Trotters are also racehorses. Instead of running they pace or trot.

SPERRY NEW HOLLAND

The quarter horse is the cowhand's pony.

KANSAS INDUSTRIAL DEVELOPMENT COMMISSION

Cow ponies that buck and fight are called **broncos.**



U.S. DEPT. OF THE INTERIOR

Mustangs are wild horses.

Shetland ponies are the opposite of mustangs. They are gentle enough for children to ride.

Horselovers like the **palomino** because it is such a beauty.

C. FOSSIL HORSES

You have seen that there are many kinds of horses. Have horses changed over the years? Fossils tell us about horses of the past, and about their ancestors.

Eohippus was a little animal about as big as a dog. Seventy million years ago it lived in the forests that covered Nebraska and Wyoming. The woods were its turf. It ate the greens. The woods hid eohippus from its enemies.

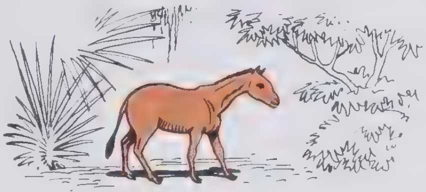
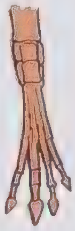
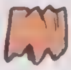
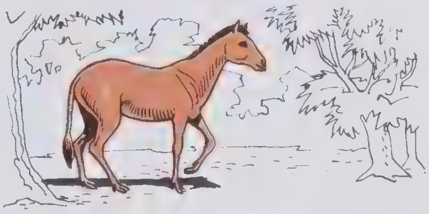
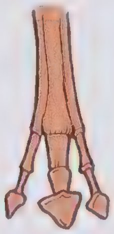
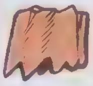
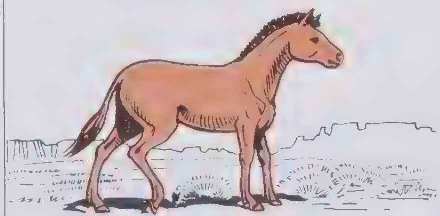
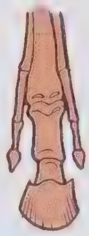
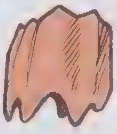
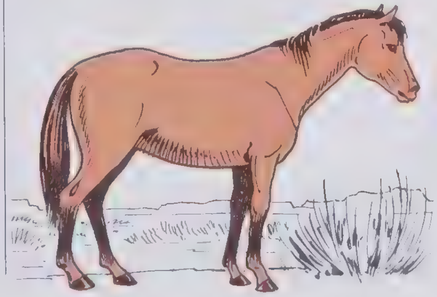
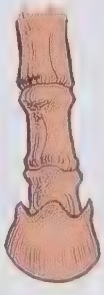
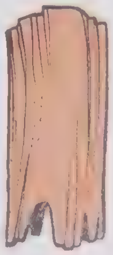
But the land changed. Grassy prairies replaced the forests.

Eohippus couldn't hide from its enemies. It couldn't run fast on the open plains. It couldn't chew the tough grass. It died out. We know eohippus only from the fossils it left.

Eohippus left descendants. These died out also, leaving their descendants. And so it went.

The table below shows some of eohippus's descendants. It will help you figure out what happened to eohippus.

FOSSIL HORSES TABLE

Fossil Animal	How Many Years Ago It Lived	Forefoot	Tooth
A. Eohippus	70 million 		
B. 3-toed leaf eater	30 million 		
C. 3-toed grass eater	15 million 		
D. Horse	1 million 		

Use the pictures in the table to help you answer the questions on the following page.

3. Which of the fossil animals had hooves?
4. On what kind of land did the hoofed animals live?
5. How did the hooves fit the animals for this life?
6. How did the home of eohippus differ from that of the fossil horse?
7. Compare the feet of eohippus and the horse. Explain the difference.
8. What kind of life were the 3-toed leaf eater's feet fitted for? Explain.
9. What kind of life were the 3-toed grass eater's feet fitted for? Explain.

The horse's long teeth wear away as they grind the horse's food of grass. However, the stubs can still chew well.

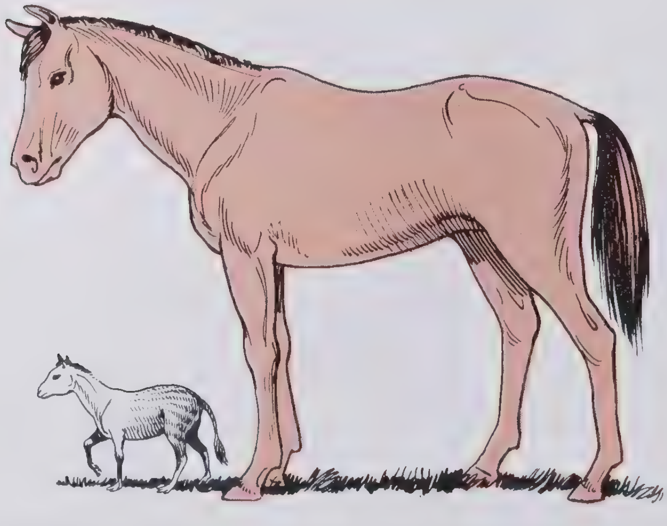
10. How did the teeth of eohippus differ from the horse's teeth?
11. How do the teeth of the 3-toed leaf-eater compare with those of eohippus and the horse?
12. Write a sentence telling how eohippus was fitted for its life.
13. Write a similar sentence about the horse.

As living conditions changed, it looks as though eohippus also changed. In several stages its descendants eventually turned into what we know as the horse. Biological scientists think this is what actually happened.

14. What do you think?

D. WHAT'S EVOLUTION?

Horses have existed for only a million years. Eohippus is much older. It seems that over the ages, eohippus and its descendants slowly changed into the modern horse.



Eohippus and modern horse

This kind of change, from one kind of living thing into a different kind, is called **evolution.**

15. Explain in your own words what evolution means.

3 EVOLUTION

As we have learned, most scientists believe that horses evolved or changed from the little animal called eohippus. This idea is called the Theory of Evolution.

The theory says that other kinds of animals and plants have also evolved or changed. Let's see why most scientists think this is so.

word guide

Tomarctus *toh-MARK-tuhs*

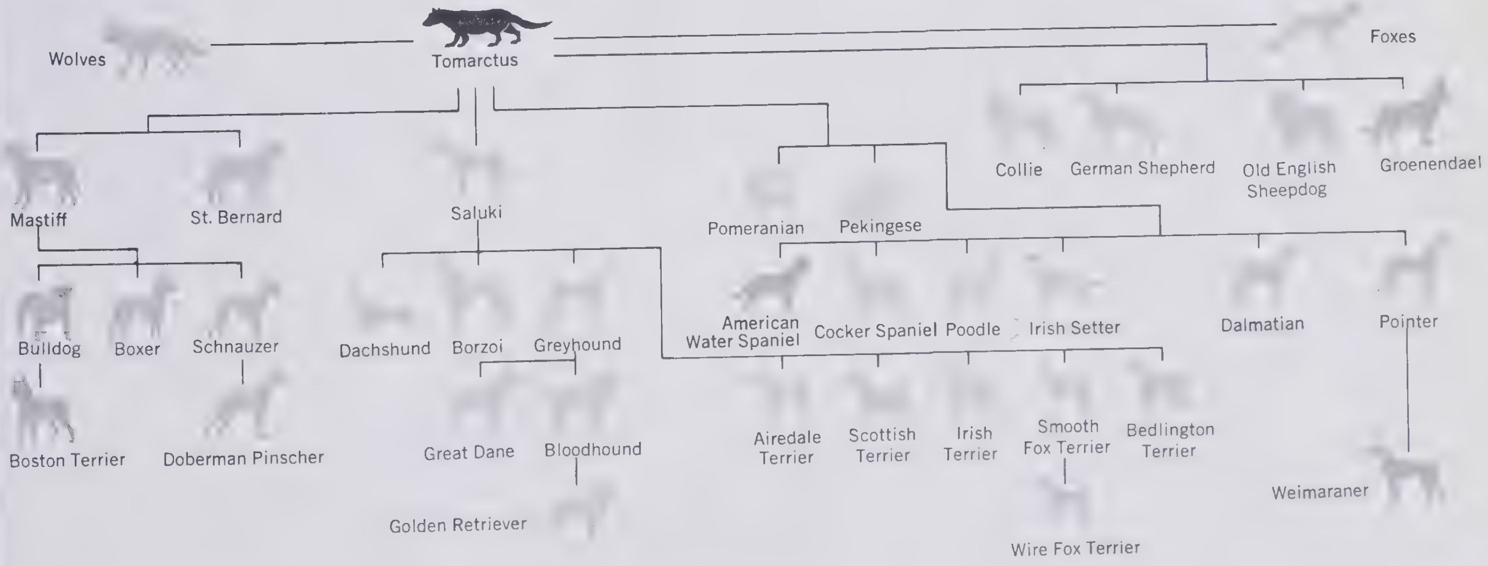
A. ROVER'S FAMILY TREE

Look at the family tree of dogs. Various types of dogs can mate with each other. All dogs seem to be related. The dog family tree shows this relationship.

The different breeds of dogs seem to come from a fossil animal called **Tomarctus.** Over many centuries, says the theory, some of its descendants evolved into dogs. Others evolved into foxes, still others into wolves.

So according to the Theory of Evolution, dogs, foxes, and wolves resemble each other because they all evolved from the same common ancestor.

Dog Family Tree

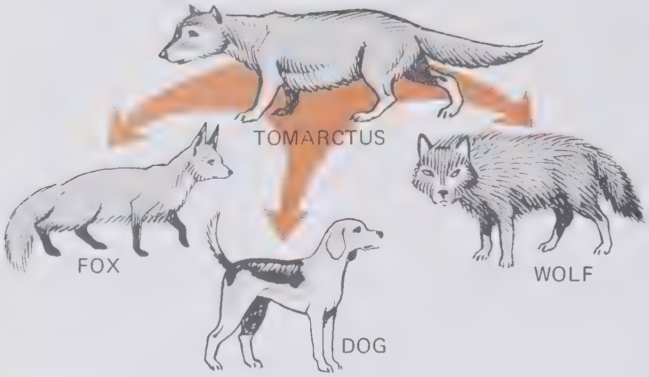


People who like dogs also like to talk about them. The dog family tree gives you a lot to talk about. See if you and your group can agree on the following:

What was Tomarctus? What animals were its descendants?

What are the closest relatives of the wire fox terrier? Of the Doberman Pinscher?

What reason is there to think that all dogs are related?



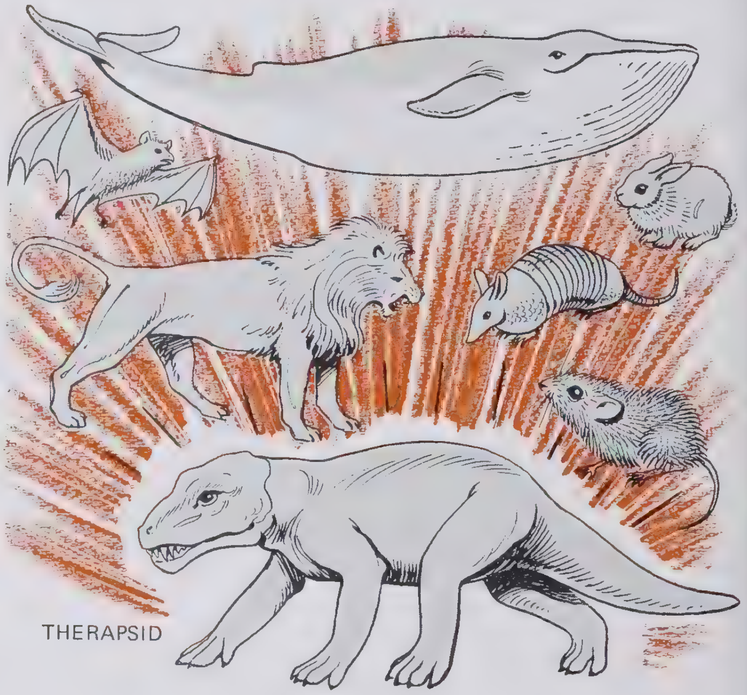
Dog-like animals

B. ARE ALL CREATURES COUSINS?

Suppose all horses are related through evolution. Suppose all dog-like animals are related. Are these different kinds of animals related to each other?

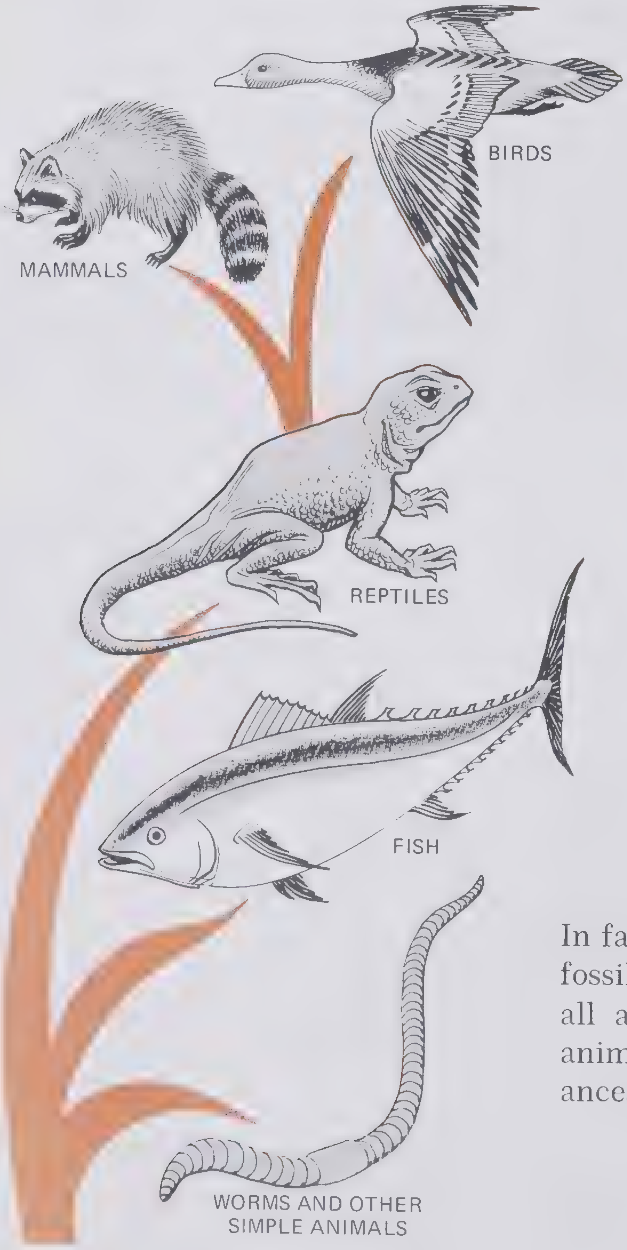
Horses and dogs are mammals. All mammals have hair, and feed their young on milk. Tigers, bears, whales, bats, and human beings are also mammals.

According to fossil evidence, all of the different kinds of mammals evolved from reptile-like ancestors.



Can you name these mammals? Evidence indicates reptile-like therapsids were ancestors of modern mammals.

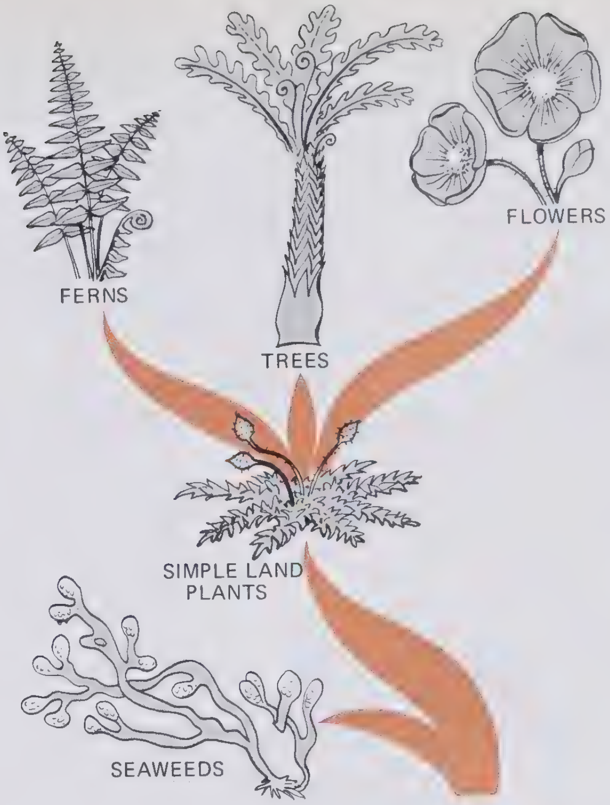
In fact, if we study living animals and their fossil ancestors, we are led to believe that all animals are related. It seems that all animals evolved from the same common ancestors.



How animals evolved

1. According to the chart, what animals besides mammals evolved from reptiles?
2. What were the ancestors of reptiles? Of fish?

Most scientists believe that plants also evolved from common ancestors.



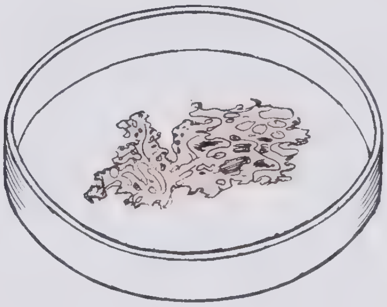
How plants evolved

At this point a big question is probably bugging you. Are animals and plants related to each other? The SLIME MOLD ACTIVITY may help answer this.

SLIME MOLD ACTIVITY

A

Get a dish of food with a slime mold growing in it.



B

Examine the slime mold with the naked eye and with a microscope.

3. Describe the slime mold. Does it move?

C

Poke the slime mold lightly with a needle.

4. How does it react?

D

Place a drop of weak acid on it.

5. What happens?

E

Place several pieces of oatmeal near it, and watch.

6. How does it react to oatmeal?
7. How are slime molds like animals?
8. Like plants?

F

Label dish and store until tomorrow.

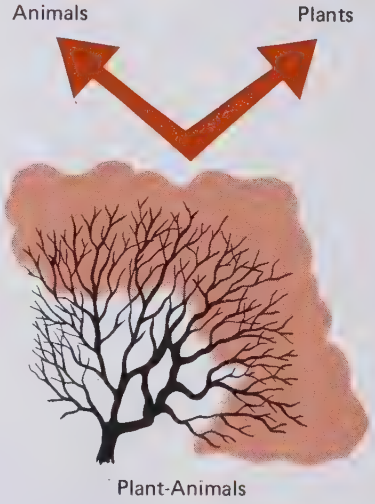
G

Next day take another careful look. Change answers if you want to.

C. THE STRANGE SLIME MOLDS

Slime molds are called plant-animals. They resemble both groups.

Most scientists think that plant-animals—creatures a little like slime molds—were the ancestors of both plants and animals.



How living things may have evolved

D. SEPARATE CREATION

Not everybody accepts the idea that all life evolved from common ancestors. Not everybody believes in the Theory of Evolution.

Some people believe that each kind of plant or animal was created separately. They believe that one kind of creature does not change into another kind. They believe that there are no common ancestors of different groups.

You are entitled to make up your own mind about accepting evolution or separate creation. Think over the evidence before you decide.

9. Do you think that evolution has occurred?

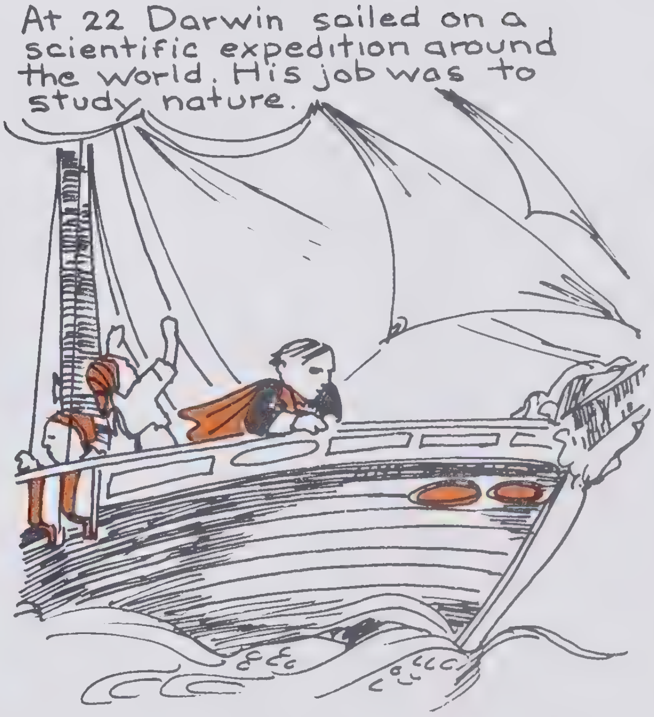
4 VARIATION

You know that no 2 people are alike. All people differ. Are the same kinds of differences found in other groups of living things?

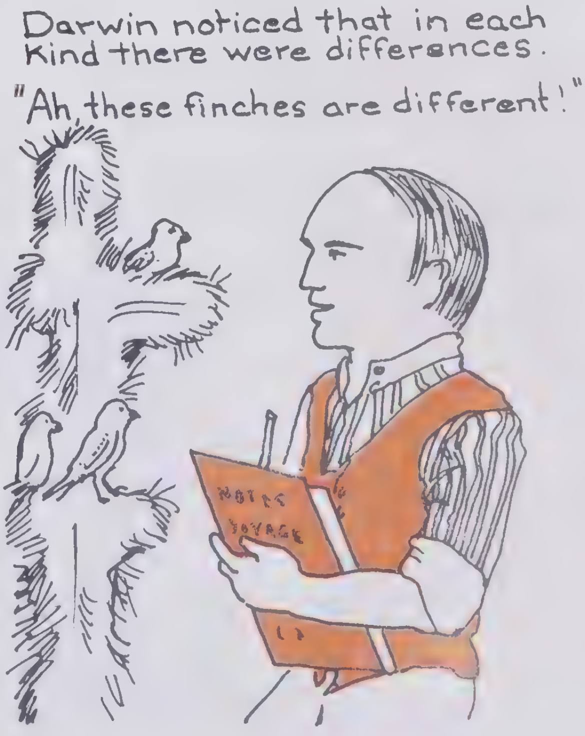
Charles Darwin was an Englishman who asked that question.

word guide
variation
vair-ee-AY-shuhn

As a boy, Charles Darwin did not like school. He liked hunting, fishing, collecting rocks and everything about nature.


At 22 Darwin sailed on a scientific expedition around the world. His job was to study nature.

His interest in the job made Darwin a real student. He observed many kinds of plants and animals.
NOTES
VOYAGE
BEAGLE
C. DAR

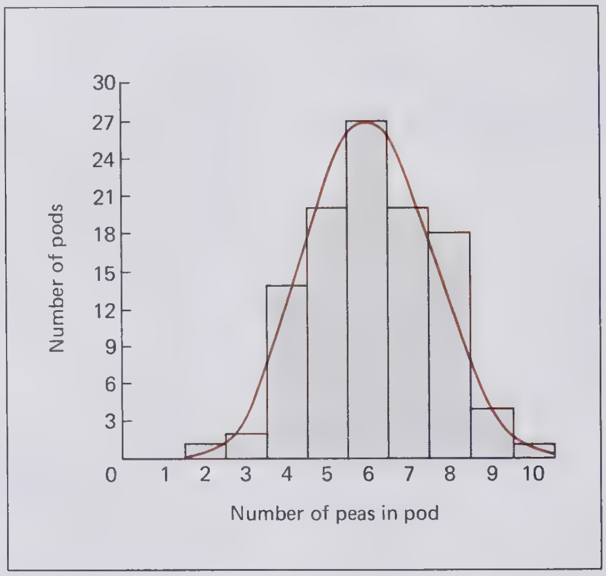

Darwin noticed that in each kind there were differences.
"Ah, these finches are different!"
NOTES
VOYAGE

A. THE BELL SHAPED CURVE

Darwin found that in nature any feature in a group of related animals or plants will differ. Arms are never the same length. Noses are never the same shape. No two people have the same number of hairs on their head.

Darwin called these differences **variations.** Look at the graph of variation in the number of peas in pods and answer the questions.

Number of peas in the pod



1. What is the shape of the curve that is drawn on the bar graph?
2. What is the most common number of peas in a pod?
3. What are the least common numbers of peas in pods?
4. What is the range, from high to low, of number of peas in pods?
5. On the graph, what is compared to what?

When you have answered these questions, do the REACTION-TIME ACTIVITY with your partner.

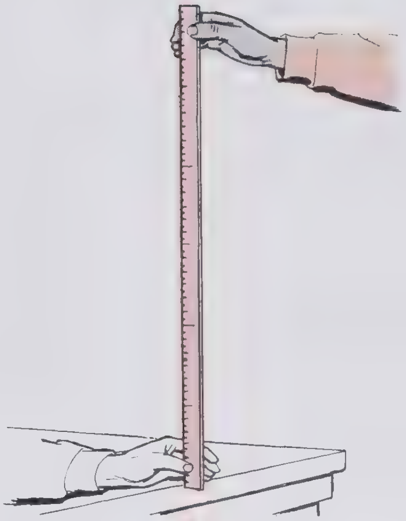
REACTION-TIME ACTIVITY

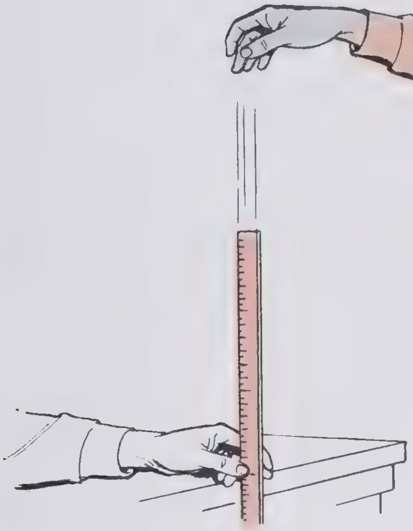
A

Your partner rests one arm on the table.

B

Hold a measuring stick between your partner's fingers, with the fingers at the "one" mark.





C

Let go. Your partner must catch the stick.

D

Note where the stick is caught. For a mark between 2 numbers record the lower number. Do this 15 times. Record the results on a table like this.

REACTION CHART

Catch	Mark
1	
2	
3	
↓	
15	

E

Change places. Your partner will now drop the measuring stick. Record results on a table as in D above.

F

$$\text{Average Mark} = \frac{\text{Total of Marks}}{15}$$

Figure the average mark for you and your partner.

G

Record these averages on the board.

H

Use the average marks from the board to make a graph like the one on page 338 (18). Answer the following questions.

6. What is the shape of the graph that you have made?
7. What is the most common average mark for the class?
8. What are the least common average marks in your class?
9. What is the range, from high to low, of average marks in your class?

This activity is an indirect way of measuring reaction time.

10. Based on the graph you have made, which average mark stands for the fastest reaction time? The slowest?

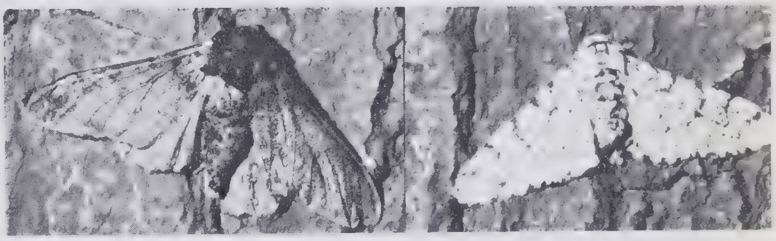
B. GRADING ON A CURVE

Some teachers grade on a curve. They say that students vary. Therefore, they feel grades should vary the same way. So the number of A's, B's, C's, and D's they give make up the bell-shaped curve.

11. Do you think grading on a curve is fair? Discuss this with your class.

5 THE MOTHS OF ENGLAND

There are some insects in England called peppered moths. The moths are often found on tree trunks. Birds eat them. The moths try to escape from the birds.


COURTESY AMERICAN MUSEUM OF NATURAL HISTORY

Peppered moths may be light or dark colored.

A. THE EARLY BIRD DOESN'T ALWAYS CATCH THE MOTH

A scientist named Henry Kettlewell experimented with peppered moths. You and your partner can do an experiment like Kettlewell's. Do the MOTH ACTIVITY.

MOTH ACTIVITY

A

Mix 20 light and 20 dark chips in an envelope. The chips stand for different colored moths.

B

You are a moth-eating bird. While your partner holds the envelope, reach in and pull out the first moth you see. Do this 10 times. Count the light and dark moths you have eaten.

C

Replace the moths in the envelope. Mix well. Change places with your partner. Add your partner's moth count to yours.

1. Did you and your partner eat more light moths or dark moths?
2. How do you explain this?

This moth experiment is for real. A hundred years ago most of the peppered moths in England were light-colored.

The tree trunks were light-colored too. Light moths were safely hidden on the light-colored trees. The moths survived and had offspring.

Dark-colored moths were also born, but the birds easily caught them. So the moth population stayed light-colored.

Nature selects light moths to survive

B. NATURE HAS FAVORITES

Natural conditions were in favor of the light moths. We can say that nature selected light moths to survive.

Nature doesn't have permanent favorites. Under different conditions natural selection favors dark moths.

Factories were built in England. They poured out black smoke. Many tree trunks turned dark.

Conditions change

3. Which moths now showed up against the tree trunks and were eaten?
4. Which moths survived and had offspring?
5. How did natural selection now favor the dark moths?

The change from light-colored to dark-colored moths is an example of evolution. Natural selection made the peppered moth evolve from light to dark.

Lately the campaign against air pollution has cleaned up many factories. They pour out less smoke. The tree trunks are cleaner. Now the peppered moths are evolving back toward the lighter color.

Now nature selects dark moths

C. WE ARE ALL LIKE THE MOTHS

Charles Darwin had the idea that natural selection is a main cause of all evolution. Remember, he said that all living things vary.

Varieties that fit particular conditions are able to survive—like the light moths on the light tree trunks, or the dark moths on the dark tree trunks.

Those that don't fit the conditions die out. As conditions change, natural selection makes living things also change or evolve.

Let's see how this idea works out.

Remember how eohippus evolved into the horse. Eohippus was small, with soft feet and weak teeth. The horse has tough hooves and strong, grinding teeth.

From eohippus to the horse

6. How did natural selection bring about this change?
7. Do you agree with Darwin that natural selection is a cause of evolution? Explain.

6 THE LUCKY DRAGON

word guide

mutation	*myoo-TAY-shuhn*
radiation	*ray-dee-AY-shuhn*

You know that:

Living things differ or vary.

Natural selection picks out some variations. These variations increase in the next generation. They cause the population to change, like the light-colored peppered moths that turned a dark color.

However, natural selection can pick out only variations that already exist.

How can it produce new variations?

How can it help new kinds of plants or animals to evolve?

A. THE UNLUCKY LUCKY DRAGON

WIDE WORLD PHOTOS, INC.

The Lucky Dragon

The Japanese catch and eat a lot of fish. The Lucky Dragon was a Japanese fishing boat.

One day it sailed into the Pacific Ocean. Suddenly, white ashes began to fall. The ashes fell for 5 hours.

The fishing crew didn't know it, but the ashes came from an American nuclear bomb test.

The fishermen felt sick. As the ship sailed for home, they got sicker. Their stomachs were upset. Their hands and feet swelled. Their hair fell out. Their blood and livers were affected.

B. BOMB SICKNESS

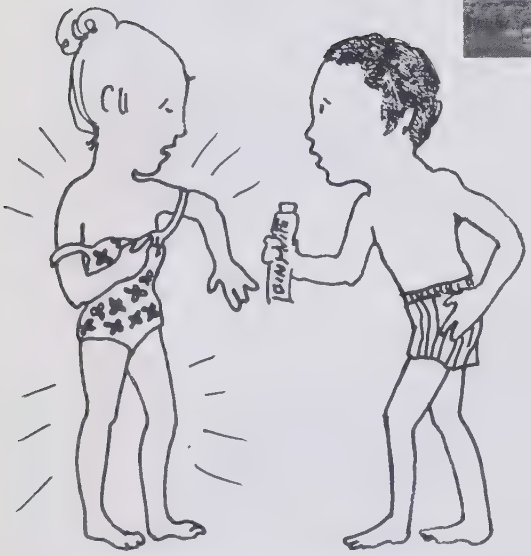
At home the men were treated. One man died. The other crew members recovered from their **radiation** sickness.

The ashes had carried radiation from the nuclear bomb test. These ashes are called fallout. Their radiation had caused the sickness.

A nuclear bomb explodes

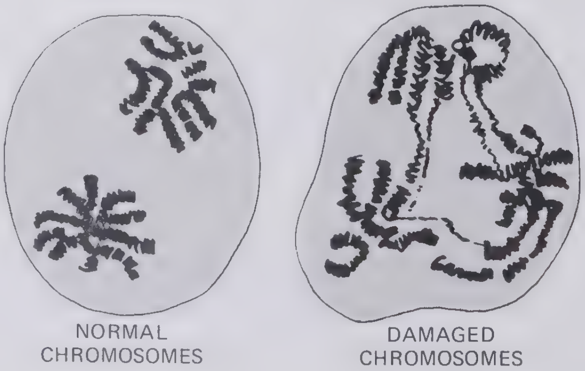
Radiation comes from places other than nuclear bombs. Sunlight is radiation. So are x-rays, heat rays, and ultraviolet rays.

Some types of radiation change the body. Sometimes the change is serious, as with the Lucky Dragon's crew. Sometimes the change is mild, as when you get a sunburn.



Sunlight is one form of radiation

Radiation affects the cells. It can change important cell structures called chromosomes, which control inheritance.



An effect of radiation

C. THE CHANGES THAT LAST

Inherited cell changes are called **mutations.** Certain chemicals can also cause mutations. Most mutations are harmful. Others are harmless. Some are useful.

A mutation is a kind of variation. It is a new variation. It never appeared before.

Some mutations affect the chromosomes of the sperm cell and the egg cell. These are passed on to the next generation.

Mutations that are passed on lead to the evolution of new creatures, like new kinds of sheep.

D. THESE SHEEP COULDN'T JUMP THE FENCE

Years ago a short-legged sheep was born on a New England farm. The farmer was pleased.

EDMUND B. GERARD

The new sheep couldn't jump the fence and run away.

The short legs were a mutation. We do not know what caused the mutation.

The happy farmer selected the short-legged sheep for breeding. A race of short-legged sheep developed.

The sheep had evolved—from long-legged animals to short-legged ones.

This selection was by a person—the farmer. The short legs were useful to the farmer but not to the sheep.

E. GREAT JUMPING SHEEP

Nature would never select short-legged sheep. They couldn't survive in the wild.

1. Why not?

These bighorn sheep result from *natural* selection. They live in the Rocky Mountains.

BUREAU OF LAND MANAGEMENT, U.S. DEPT. OF THE INTERIOR

Bighorn sheep can run like the wind, jump from rock to rock, and climb steep cliffs.

2. How did mutation and natural selection make bighorn sheep evolve? When you answer this question you will understand the difficult theory of evolution.

BOMB TEST ACTIVITY

A

The United States, and other countries, now test nuclear bombs only underground. There is less fallout than there used to be.

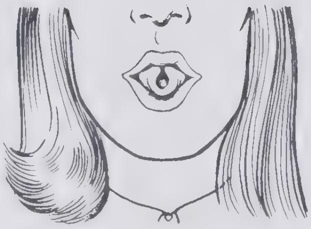
Yet some people think all tests should be stopped and all nuclear bombs destroyed. Others insist we must have the bombs for defense.

B

Imagine that a committee of Congress plans to hold a hearing on the question of banning all bombs and all bomb tests. Witnesses will present all viewpoints. Have your class conduct a hearing.

7 WHAT DO WE INHERIT?

Some people can roll their tongues, like this.



Other people cannot. Tongue rolling is an **inherited** feature.

Can you roll your tongue?

A. THE TASTE THAT DOESN'T WORK

Get a slip of paper that has been soaked in PTC, a harmless chemical. Taste it.

1. How does PTC taste?

Don't be surprised if you don't taste anything. Some people can taste PTC, others cannot. Being able to taste PTC and not being able to taste it are inherited features.

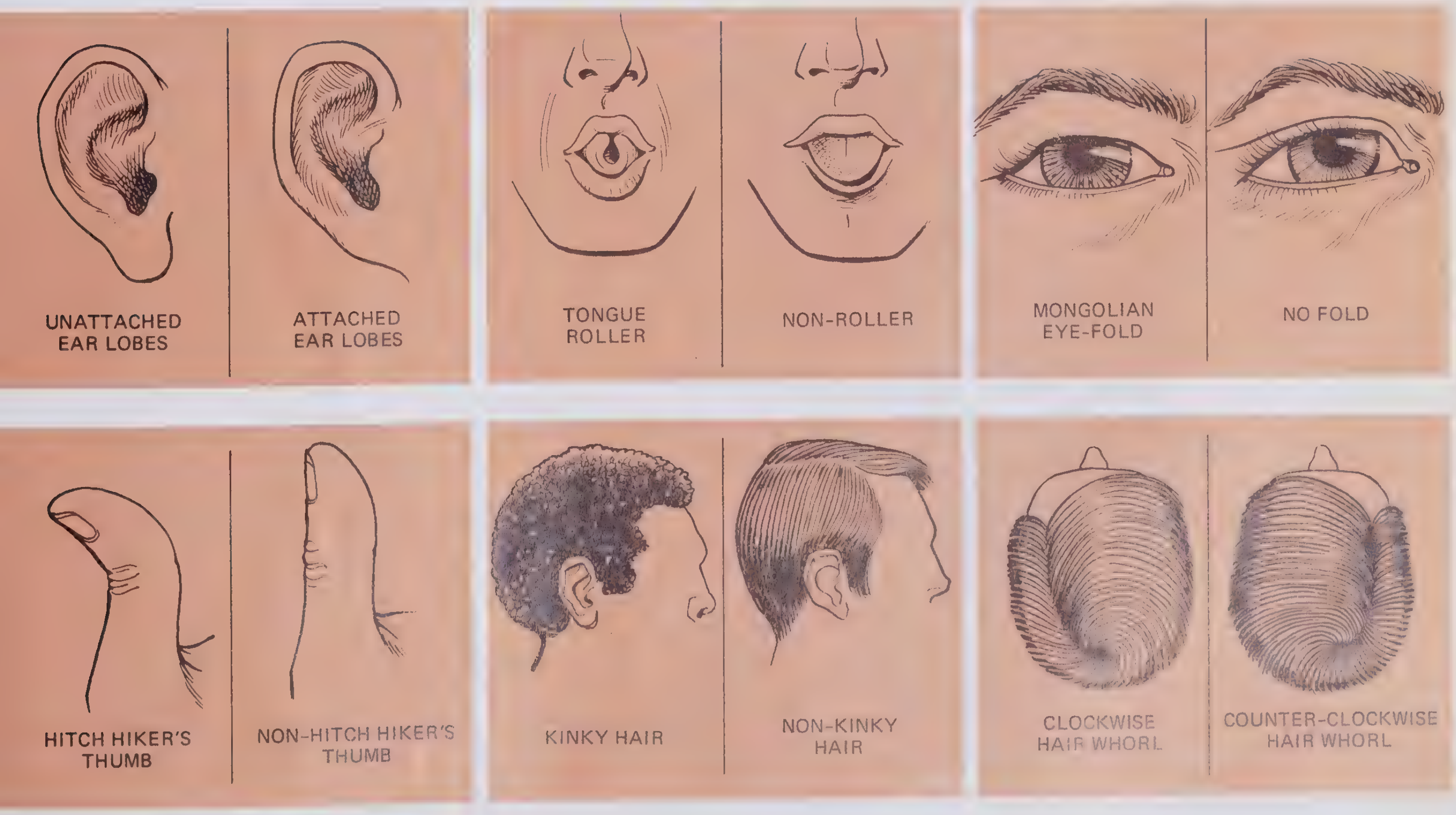
The pictures show several more such features. Which do you have?

Which of the inherited features listed on the HUMAN GENETICS WORKSHEET do you have? How many of your relatives have each feature? Write your answers in your notes.

word guide

genetics
juh-NET-iks
hemophilia
hee-muh-FIL-ee-uh
inherited
in-HER-i-tuhd

Some contrasting inherited features of human beings. You inherit one feature of each pair.



HUMAN GENETICS WORKSHEET

GENETIC FEATURE		You	No. of Relatives		You	No. of Relatives
1. Tasting PTC	taster	______	______	nontaster	______	______
2. Tongue rolling	tongue roller	______	______	non tongue roller	______	______
3. Ear lobes	attached	______	______	free	______	______
4. Mongolian eye-folds	present	______	______	no folds	______	______
5. Dimples	present	______	______	no dimples	______	______
6. Freckles	present	______	______	no freckles	______	______
7. Hair whorl	clockwise	______	______	counterclockwise	______	______
8. Widow's peak	present	______	______	no widow's peak	______	______
9. Handedness	right-handed	______	______	left-handed	______	______
10. Shape of head	long	______	______	round	______	______
11. Height (for sex)	tall	______	______	short	______	______
12. Fingers very short or very long	very short or very long	______	______	average	______	______
13. Eye color	dark	______	______	blue	______	______
14. Nearsightedness	yes	______	______	no	______	______
15. Color blindness	yes	______	______	no	______	______
16. Complexion	dark	______	______	fair	______	______
17. Hair color	dark	______	______	blonde or red	______	______
18. White forelock	present	______	______	no white forelock	______	______
19. Hitchhiker's thumb	thumb bent	______	______	thumb straight	______	______
20. Folding hands	left thumb on top	______	______	right thumb on top	______	______
21. Shape of face	like yours		______	not like yours		______

B. YOUR OWN INHERITANCE

Genetics explains why we inherit certain features but don't inherit other features.

You inherit many thousands of features. Some are of minor importance, like tasting PTC, hair whorl, tongue rolling, or having dimples.

Other features are essential. You wouldn't be here if the essential features were missing. Examples are having a head, brain, heart, lungs, and so on.

Learning genetics will help explain your own inheritance. It will help predict the kind of children you are likely to have.

Take home the HUMAN GENETICS WORKSHEET and some PTC paper. Survey your family and as many relatives as you can. Record the number of people who have each feature.

Write the results of your survey in your notes.

The survey is a good start toward understanding genetics. Meanwhile, test yourself on what you already know. Take the following SELF TEST.

SELF TEST

Do you think the following statements are T (true) or F (false)? Check your answers on page 370 (50).

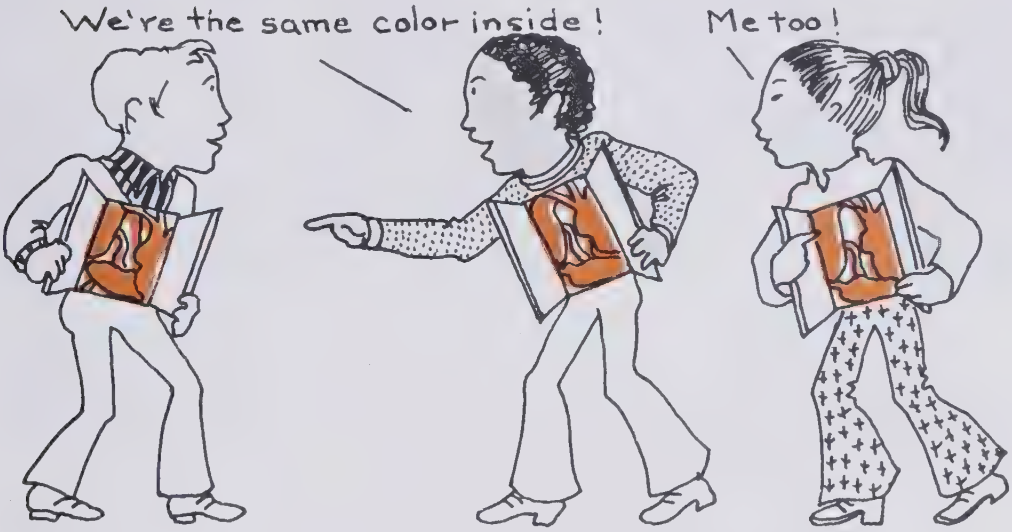
1. Inheritance is through the blood.
2. Mothers can pass on baldness to their sons.
3. We inherit intelligence.
4. Bleeder's disease (**hemophilia**) is inherited.
5. No two people are ever born exactly alike.
6. If close relatives marry, the children will be insane.
7. If a pregnant woman looks at pretty things, her child will be pretty.
8. More men than women have inherited color blindness.

8 THE COLOR OF YOUR SKIN

word guide

melanin	*MEL-uh-nin*
prejudice	*PREJ-oo-dis*
rickets	*RIK-its*

People come in many colors. The color is in their skin. Inside we are all colored the same.


We're the same color inside!
Me too!

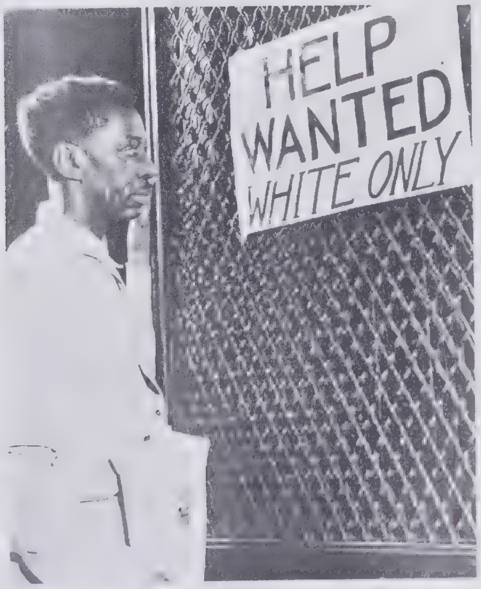
Races are often named from skin color. We hear about the black, white, red, yellow, and brown races.

A. BROWN IS BEAUTIFUL

You surely know about color or race **prejudice.** There are people who judge others by their color. They say:

"If you are my color you are OK. Other races are inferior."

Some who don't say this still think it.



NAACP

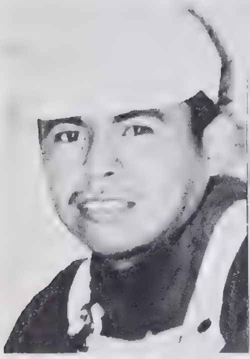
A 1957 scene. Would you see it nowadays?

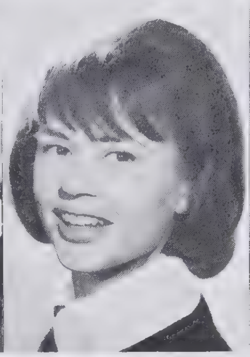
Prejudice usually springs from ignorance. Lots of people are poorly informed about race and color.

How well informed are you? Test yourself on the RACE AND COLOR WORKSHEET.

Race and Color Worksheet

The people shown in the pictures belong to different national or racial groups. In your notes write the letter for each person next to the name of the group you think he or she belongs to.


a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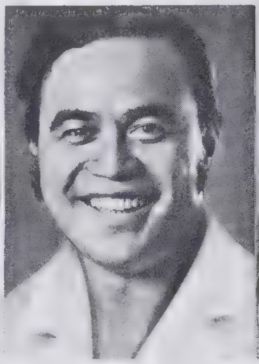
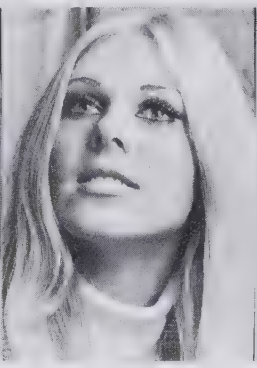
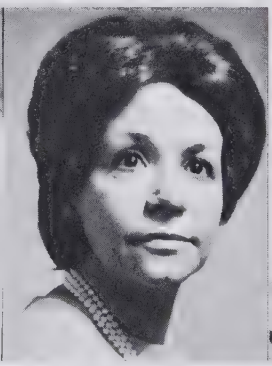
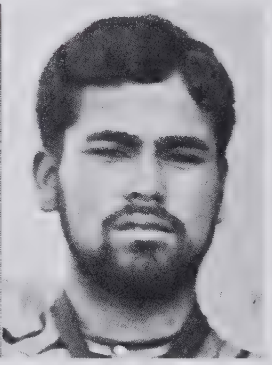

c


d


e


f

1. White Ainu from Japan
2. Israeli
3. Swede
4. American Negro
5. American Indian
6. Hawaiian

ANSWER EACH OF THE FOLLOWING STATEMENTS AS EITHER TRUE OR FALSE

7. Nobody has red, white, or yellow skin.
8. Some people are naturally colored pink.
9. Not getting enough sunlight can weaken the bones.
10. Blacks are well adapted to living in the tropics.
11. Whites are well adapted to living in the north.
12. Blacks, whites, and American Indians have the same coloring matter in their skin.
13. People of all races are colored the same inside.
14. Race prejudice often springs from ignorance.
15. You cannot tell race from a person's blood type.
16. There is no color in the outer layer of the skin.
17. Some people can make extra coloring matter in their skin.
18. The color of blood sometimes shows through the skin.
19. Melanin colors all normal skin.
20. There is no connection between skin color and intelligence.

Before you are given the correct answers, read the rest of this chapter.

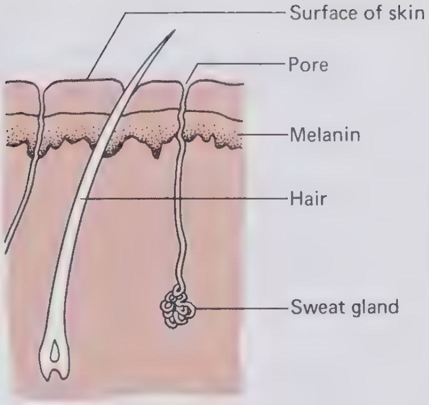
PHOTOGRAPHS COURTESY OF: (a) U.S. BUREAU OF INDIAN AFFAIRS; (b) SWEDISH INFORMATION SERVICE; (c) HAWAII VISITORS BUREAU; (d) JACQUES BEN BASSAT, DEWYS, INC., (e) N.Y. MEDICAL COLLEGE; (f) AMERICAN MUSEUM OF NATURAL HISTORY.

B. COLOR IN THE SKIN

Let's see what the real score is on race and skin color.

Your skin has 3 layers of cells. The outer layer is made of dead cells that constantly peel off. It gives protection.

The color is in the middle and lower layers. These layers contain a dark brown dye called **melanin.**



Cross section through the skin

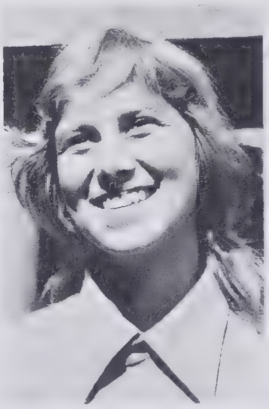
Oriental has light brown skin

Brown-skinned Indian girl

People of all races have melanin in their skin. Black and dark brown people have lots of melanin. People whose skin is lighter brown, "yellow," or "red" have less melanin.

Chinese and American Indians are various shades of brown. All these colors are due to melanin.

White people have the least melanin, but even the fairest blonds have some. "Whites" actually look pink because the blood shows through their light-colored skin.



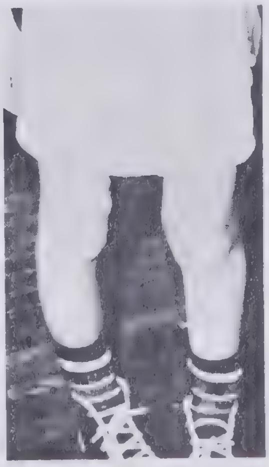
Blondes are pink

C. SUNLIGHT IS GOOD

Melanin is useful. It gives protection against strong sunlight.

Sunlight is good for you—in small doses. It turns a natural skin oil into vitamin D. This vitamin builds strong bones and prevents the disease, **rickets.** In this disease the bones weaken and bend.

Light-colored skin absorbs sunlight better than dark skin does. So whites are well protected against rickets.



CENTER FOR DISEASE CONTROL, ATLANTA, GA.

Rickets may cause bow legs

At the beach

D. SUNLIGHT IS BAD

But too much sunlight is harmful. It burns the skin. It makes too much vitamin D which causes a dangerous overgrowth of bone. It can also cause skin cancer.

Whites have some protection against strong sunlight. They tan. That is, they make extra melanin. The tan protects them temporarily.

But dark-skinned people have better and more permanent protection. They rarely make extra vitamin D. Fewer blacks than whites have skin cancer.

So which skin color is better? Neither dark skin nor white skin is superior. Each has its advantages.

How does her dark skin protect this Nigerian girl?

MOBIL OIL

NATIONAL INSTITUTES OF HEALTH

Giving blood

E. BROTHERS UNDER THE SKIN

If differences in skin color are not so important, are there other big differences among races?

People of all races can have children together.

People can give blood to those of another race, so long as both have the same blood type. All the main blood types occur in all races.

MASSACHUSETTS RED CROSS PHOTO

Transplants of parts of the body can be made between races.

The resemblances among races are greater than the differences. Whatever our skin color, we all belong to the same human race.

Go back to the RACE AND COLOR WORKSHEET. Change any answers that you wish. Then, check your answers on page 356 (36).

9 PEAS AND PEOPLE

When people see a new baby, they often say: "Isn't she the image of her father!" Or: "He has his mother's eyes."

word guide

dominant	*DOM-uh-nuhnt*
hybrid	*HY-brid*
recessive	*ri-SES-iv*

PHOTO BY BRADFORD HERZOG, COURTESY OF BOSTON HOSPITAL FOR WOMEN

How does a baby get its mother's eyes? The first hint of an answer to this question came from experiments with peas.

The pea experimenter was a bright young man named Johann Mendel.

A. MENDEL'S FIRST DISCOVERY

a. Mendel was a priest and a science teacher. While teaching, he experimented with pea plants in the school garden.

b. Peas grow on vines. The peas develop from flowers. Pea flowers may be red or white.

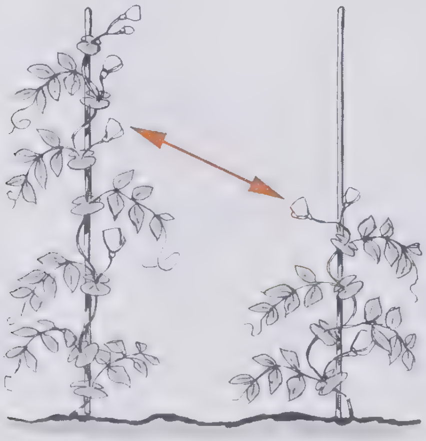
c. The peas may be round or wrinkled.

d. The vines may be tall or short. Pea vines have many other pairs of opposite features.

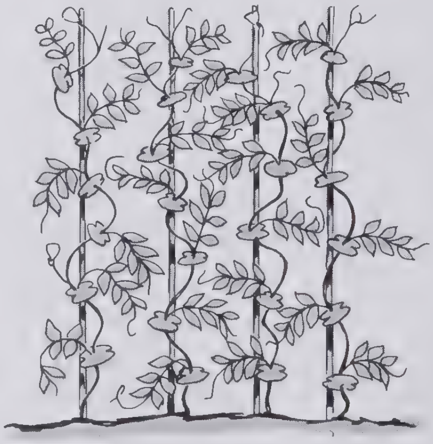
e. Mendel planted 14 different types. Each year he picked the peas. He planted them to get new vines.

f. He repeated this until he was sure his vines were pure. A pure type stays the same from one generation to the next.

g. Then Mendel chose 2 grandparents. He bred a vine of pure short type with a vine of pure tall type.



h. The resulting parent generation all looked like this.

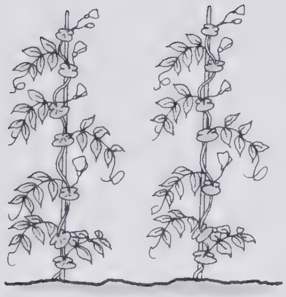


1. How did Mendel know when his plants were pure?
2. How did the grandparent vines differ?
3. Which grandparent did the parent vines resemble?

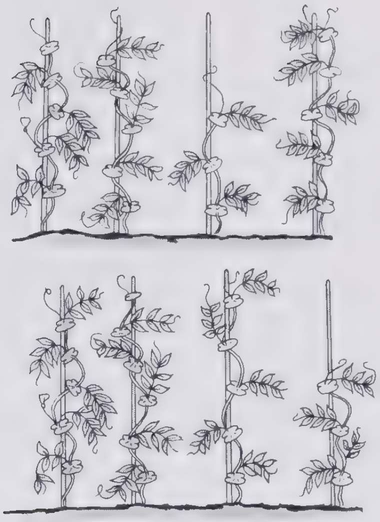
The parents were **hybrids.** A hybrid comes from parents with different, contrasting features. Only one of the features shows in the hybrid. Mendel called this the **dominant** feature.

Dominant features were Mendel's first discovery. Mendel thought that hybrids might also carry a hidden feature.

B. MENDEL'S SECOND DISCOVERY



i. Mendel bred the hybrid parents.



j. The offspring looked like this.

4. In the hybrid parents, which was the dominant feature? The hidden feature?
5. Where did the hidden feature show up?
6. How many vines show the dominant feature?
7. How many show the hidden feature?

Mendel repeated this experiment with other types of pea vines. Each time that he bred hybrids he studied the offspring. Each study showed 3 times as many offspring with the dominant feature as with the hidden feature. He called the hidden feature **recessive.**

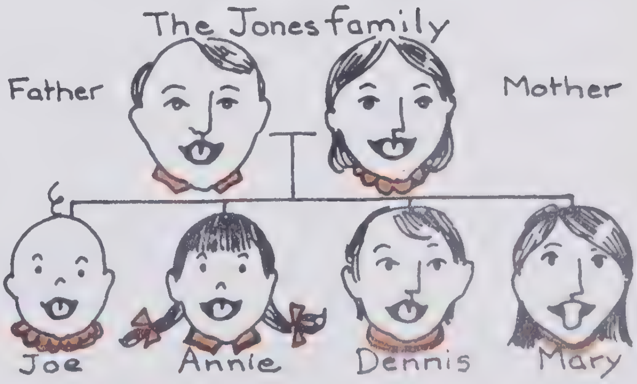
Mendel made his second discovery: In the offspring of hybrids, the odds are 3 to 1 on the dominant feature as compared to the hidden or recessive feature.

Mendel's discoveries started the science of genetics. Genetics studies how living things inherit their features.

C. THE JONES FAMILY

Mr. and Mrs. Jones can roll their tongues. Can you roll yours?

Three of the Jones children can also roll their tongues. But Mary Jones is not a tongue roller.



Peas will help you find out why Mary Jones cannot roll her tongue. Peas and people follow the same rules of genetics. And you now know some of the rules of genetics.

You know that:

Some inherited features are dominant. Others are recessive.

A hybrid has dominant and recessive features. But only the dominant shows.

When hybrids have offspring, the odds are 3 to 1 that the children will show the dominant feature.

The last rule works in reverse, too. In a family where there are 3 dominant-type offspring and 1 recessive-type, the parents very likely are hybrids.

8. What can you probably say about Mother and Father Jones?

If you can answer the next question you are really swinging.

9. Why can't Mary Jones roll her tongue?

D. LET'S REVIEW

Mendel is famous because of his discoveries in genetics. Mendel's discoveries apply to all living things.

10. In your own words, explain the meaning of each of these terms that Mendel used:
    - dominant feature
    - hidden or recessive feature
    - hybrid
    - pure

RACE AND COLOR WORKSHEET Answers for page 350 (30).

1. **f**
2. **d**
3. **b**
4. **e**
5. **a**
6. **c**
7. **T**
8. **T**
9. **T**
10. **T**
11. **T**
12. **T**
13. **T**
14. **T**
15. **T**
16. **T**
17. **T**
18. **T**
19. **T**
20. **T**

10 ABOUT GLEEPS

The gleep is an imaginary animal. It is a friendly little thing, and nuzzles up to people.

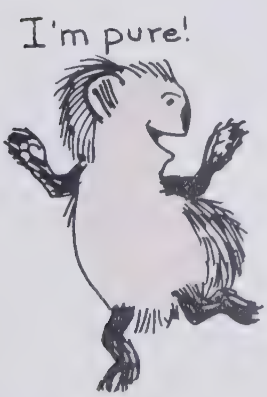
Gleeps come in brown or white. They reproduce sexually. They pass on their colors to their young.

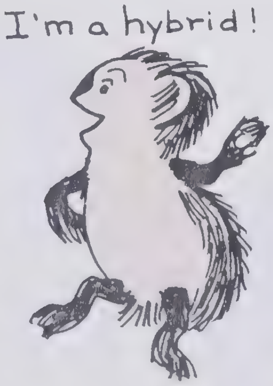
Inheritance in gleeps follows the same rules as in peas and people.

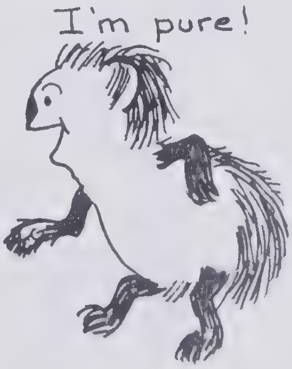
This is fortunate. The little imaginary gleep helps us to understand the genetics of real living creatures.

A. LOVE THOSE GLEEPS

Gleeps may be pure or hybrid. The pictures will help you answer the questions about them.







1. Are all white gleeps pure or hybrid?
2. Some brown gleeps also are pure. What are the others?
3. Do pure and hybrid brown gleeps look alike or different?
4. What color must hybrids always be?

B. GLEEP INHERITANCE

Let's look at a hybrid gleep carefully. Remember, it is brown. Its parents were pure.

5. What colors were the parents?

Parents pass on to their offspring something that gives inherited features. Let's call this "something" a gene.

Let us see from which parent or parents the hybrid gleep inherits its color genes.

Do the GLEEP ACTIVITY—PART I. You will use brown plastic chips for brown color genes. Clear plastic chips will stand for white color genes.

GLEEP ACTIVITY–PART I

A

One container stands for brown parent. Put in brown chips.

B

Other container stands for white parent. Put in clear chips.

C

Without looking, take one chip from each container. You have crossed or mated the parents.

6. How many color genes does the hybrid baby gleep have?

D

Put the chips together. Look at the light through them.

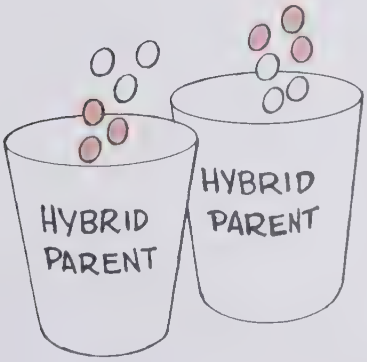
7. When you put the chips together, what color do you see?

8. Why are hybrid gleeps always brown?

C. MATING HYBRID GLEEPS

Now let's cross 2 hybrid gleeps to see if we get a familiar pattern. Do the GLEEP ACTIVITY—PART II.

GLEEP ACTIVITY—PART II



E

The containers now stand for hybrid parents. Place 10 brown and 10 clear chips in each container. Mix well.

F

Remember that each parent gives one color gene to each offspring.

G

Shut your eyes. Take a chip from each container.

H

You are holding the color genes of a baby gleep. Put the chips together and look through them. Your partner records the color in the table. Copy the table into your notes.

TABLE—MATING OF HYBRID GLEEPS

Offspring	Pure Brown (brown, brown genes)	Hybrid Brown (brown, white genes)	Pure White (white, white genes)
Mark Your Results in These Boxes			
Your Totals			
Totals From 2nd Team			
Totals From 3rd Team			
Grand Totals			

I

Return chips to original containers and shake.

J

Cross hybrids 20 times and record results. Let your partner make 20 crosses.

K

Get results from other teams. Complete the summary on the right.

9. What is the ratio of brown to white baby gleeps from hybrid parents?

10. Describe the parents of these babies.

11. Where else have you seen this kind of inheritance?

Grand total of brown gleeps ________

Grand total of white gleeps ________

$$\text{Ratio} = \frac{\text{grand total of brown gleeps}}{\text{grand total of white gleeps}} =$$

D. GLEEPS, PEOPLE AND THINGS

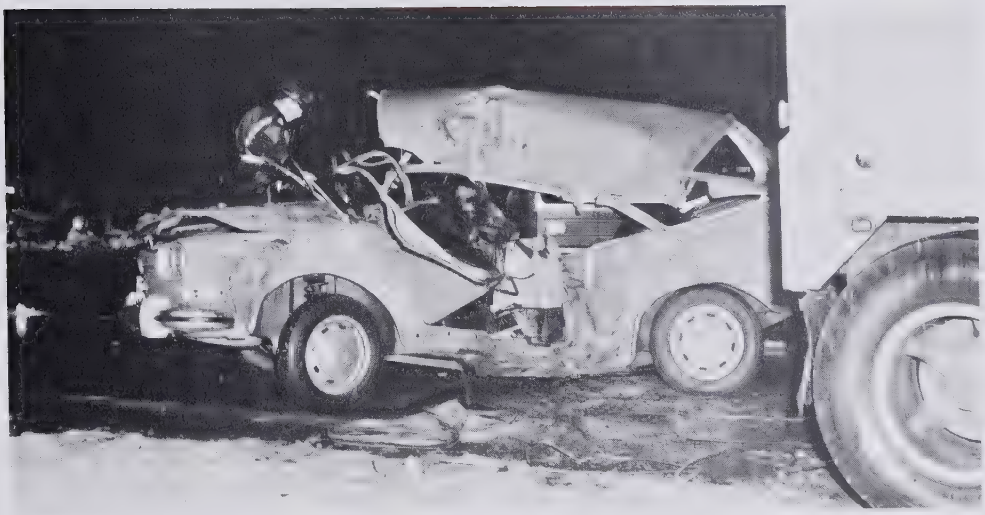
Let's try to apply the gleep inheritance pattern elsewhere.

12. What features always show in a hybrid?
13. Why can people who are hybrid for tongue rolling always roll their tongues?
14. How can hybrids have offspring that show the recessive feature?

11 BLOOD TYPES

word guide

antibodies	*AN-ti-bod-eez*
transfusion	*trans-FYOO-zhuhn*



MASSACHUSETTS STATE POLICE

Maria Montoya was badly hurt in this car wreck. She was rushed to the hospital.

The doctors saw that she needed blood. But before giving her a transfusion, they quickly sent a sample of her blood to the blood bank.

At the blood bank the technician typed Maria's blood. She took a bag of the right type of blood from the refrigerator and rushed it to the operating room. The blood **transfusion** helped save Maria's life.

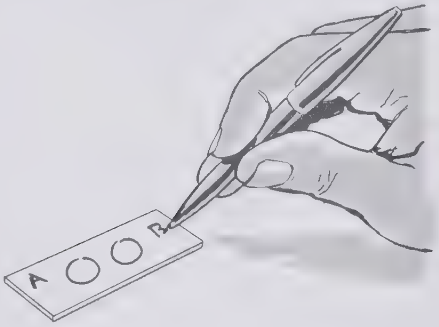
The wrong type of blood would have killed Maria. Let's see why blood type makes a difference.

COURTESY MERLIN SMITH, N.E. MEDICAL CENTER HOSPITAL

A bag of blood, type B positive

A good way to start is to type your own blood or blood supplied by your teacher. Do the BLOOD-TYPING ACTIVITY.

BLOOD-TYPING ACTIVITY

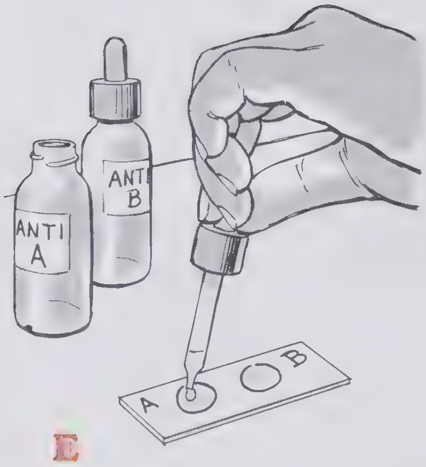


A

Mark slide as shown.

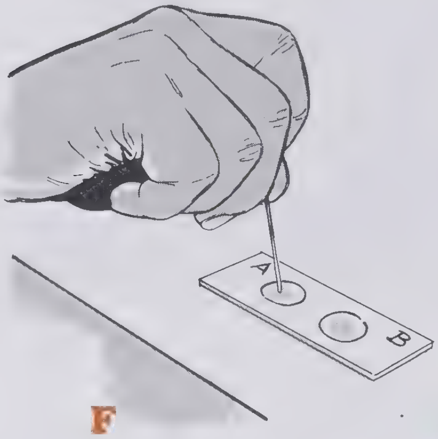
B

Draw blood safely, as you have learned, or use blood supplied by your teacher.



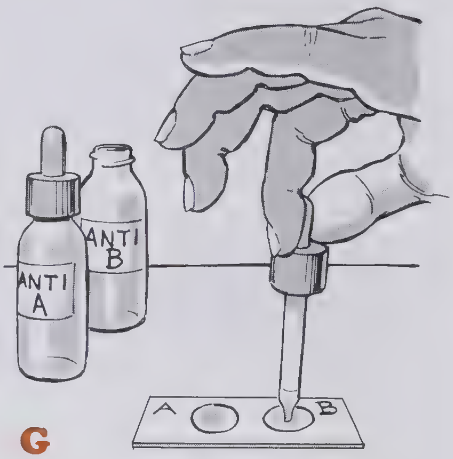
E

Add **anti-A** serum to **A** circle.



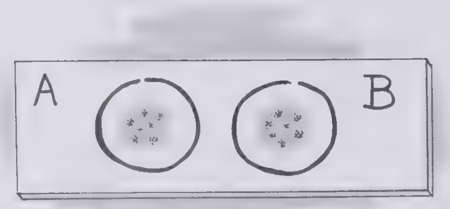
F

Stir with toothpick.



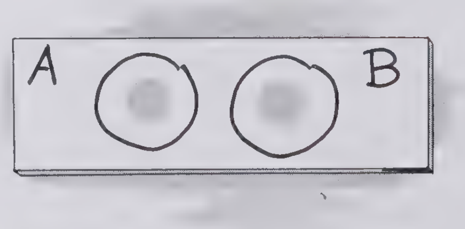
G

Add **anti-B** serum to **B** circle.



K

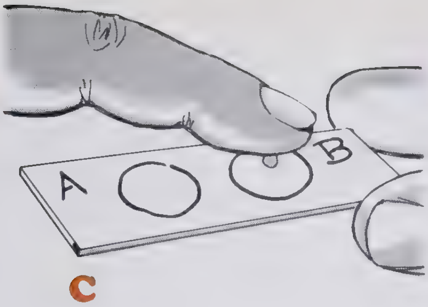
Both sides clump. Blood is type **AB.**



L

Neither side clumps. Blood is type **O.**

1. What is your blood type? Caution: Only a medical doctor or lab technician can safely identify your blood type.



C

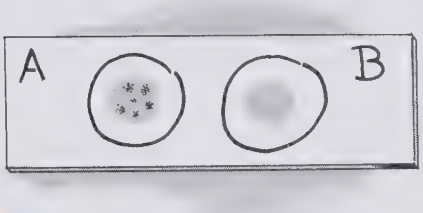
Put one drop in each circle.

D

If you drew your own blood, sterilize finger as you have learned.

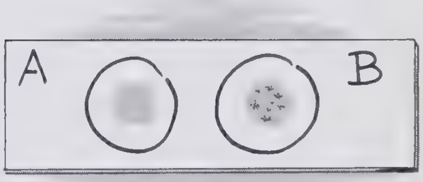
H

Use other end of toothpick to stir.



I

Look for clumps. Here **A** side is clumped. **B** side is not clumped. The blood is type **A.**



J

B side clumps. **A** side does not. Blood is type **B.**

A. HOW BLOOD TYPING WORKS

The clumps tell the type of blood a person has. The clumps are what make a transfusion with the wrong blood type dangerous.

In the blood there are trillions of red blood cells. The cells are covered with certain proteins. There are **A** proteins and **B** proteins.

The chart shows the blood cell proteins present in blood of different types.

BLOOD TYPING CHART

Blood Type	Proteins Present	Antibodies Present
A	**A**	**anti-B**
B	**B**	**anti-A**
AB	**A** and **B**	None
O	None	**anti-A** and **anti-B**

Other chemicals called **antibodies** are dissolved in the blood. Certain antibodies react with certain proteins. The reaction makes red blood cells stick together and clump.

Which antibodies react with which proteins? The letters tell you. **Anti-A** reacts with protein **A. Anti-B** reacts with protein **B.**

B. WHO HAS THIS ALPHABET SOUP?

2. What type of blood contains **anti-A** antibodies? **Anti-B** antibodies?
3. Why can an **A** type person never have **anti-A** antibodies? What would happen if she or he did have them?

The typing serum you used in the BLOOD-TYPING ACTIVITY came from human blood. The colors were added so you would not mix up the bottles.

4. What type of person gave the **anti-B** serum?
5. Why is it harmful for blood to clump inside the body?
6. Now can you explain why transfusing the wrong type of blood is dangerous?

C. ARE BLOOD TYPES INHERITED?

Yes. The same rules of genetics that work for peas and for minor human features also work for blood types.

There are 2 dominant genes. One is for protein **A,** the other for protein **B.** There is a recessive gene for no protein. It is called **O.**

With this information, solve the blood type picture puzzle.

BLOOD TYPE PICTURE PUZZLE

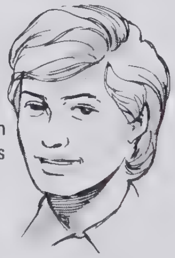
WHAT ARE THEIR BLOOD TYPES?

(HINT: Remember that each person has 2 blood type genes, but only one blood type.)

John has gene A and gene O

Rose is pure for gene A

Joan is pure for gene O


Kurt has both dominant genes

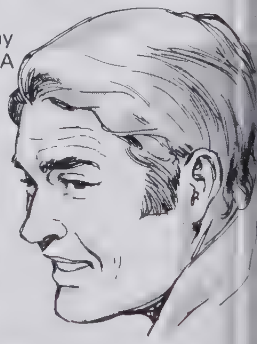
D. JUDGE AND JURY NEEDED

Besides being needed in transfusions, blood types have other uses. Elena claimed that Johnny was the father of her baby. Johnny denied this. Elena took him to court.

The judge ordered all 3 people tested for blood type. These were the results:

Elena
Type A

The baby, Type B


Johnny
Type A

Act out the court case. You will need a judge, jury, 2 lawyers, and expert witnesses to testify on blood typing. (HINT FOR LAWYERS: What blood type genes could each of the 3 people have?)

12 GENES ARE FOR REAL

People give inherited features to their offspring by passing on genes. There are genes for skin color, eye color, blood type, tongue rolling, and thousands of other features.

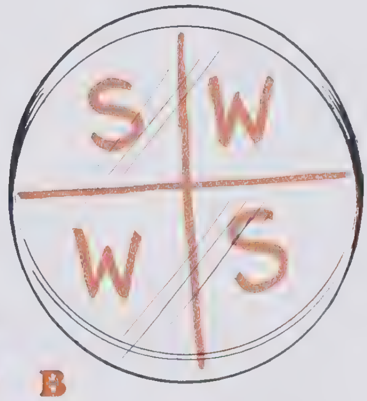
All living creatures have genes. They pass on the genes to their offspring.

In THE GENES-IN-PEAS ACTIVITY you will see 2 pea genes at work. One gene is in smooth peas, the other is in wrinkled peas.

THE GENES-IN-PEAS ACTIVITY

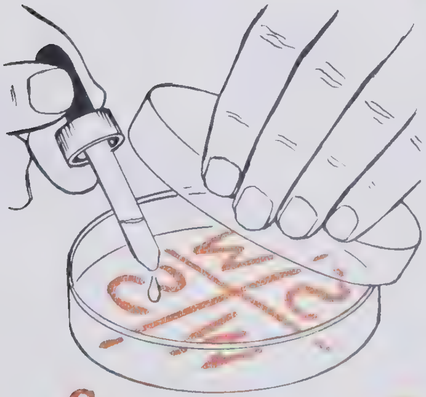
A

Get a Petri dish of agar jelly. The jelly contains sugar. Don't open the dish yet.



B

Turn the dish over. Mark the bottom like this. Label 2 quarters "S" and the other 2 quarters "W."

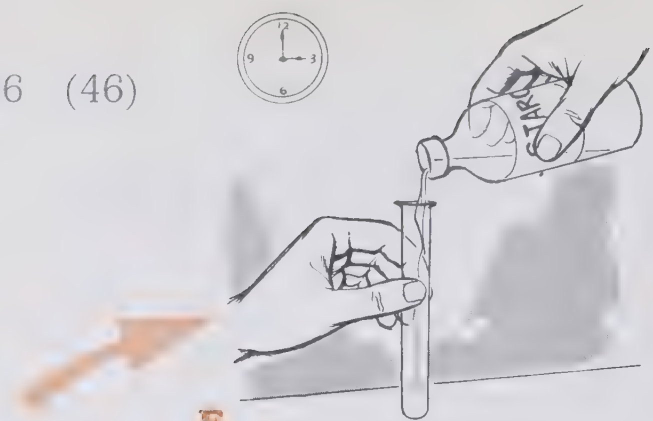


C

Get 2 bottles of mashed peas. Place one drop of mashed smooth peas in each S quarter.

D

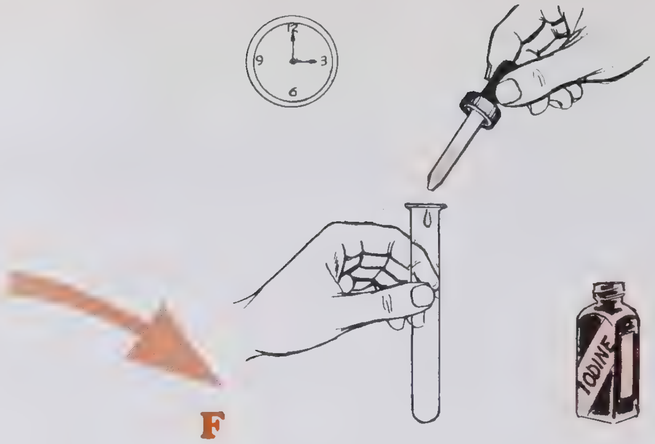
Put a drop of mashed wrinkled peas in each W quarter.



E

Wait 15 minutes. Meanwhile pour about 2 cm (one inch) of starch solution in a test tube.

1. What color is the starch solution?



F

Add one drop of iodine to the starch solution. Shake the tube. You have just done the test for starch.

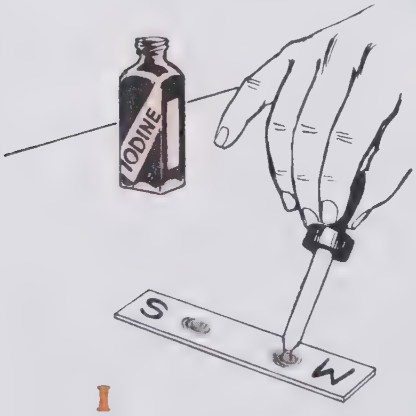
2. What color change took place?

G

Mark a microscope slide "S" at one end, "W" at the other end.

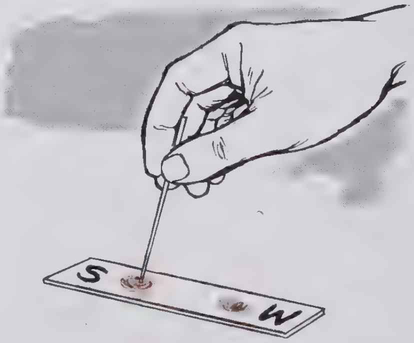
H

Place a drop of mashed smooth peas at the S end, a drop of mashed wrinkled peas at the W end.



I

Add a drop of iodine to each drop of mashed peas.



J

Stir each mixture with a separate toothpick. Then wait.

3. How did the iodine affect the mashed peas?

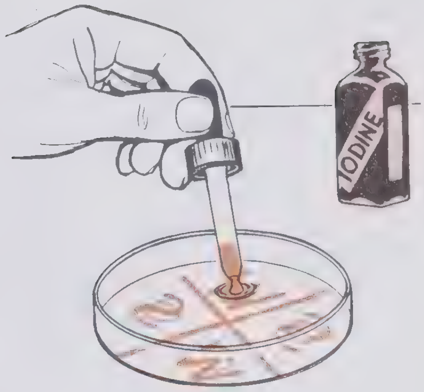
4. What did the slide test tell you about the peas?

K

Go back to your Petri dish. Carefully blot up the drops of mashed peas.

L

Find the spots that are left. Add a drop of iodine to each spot.

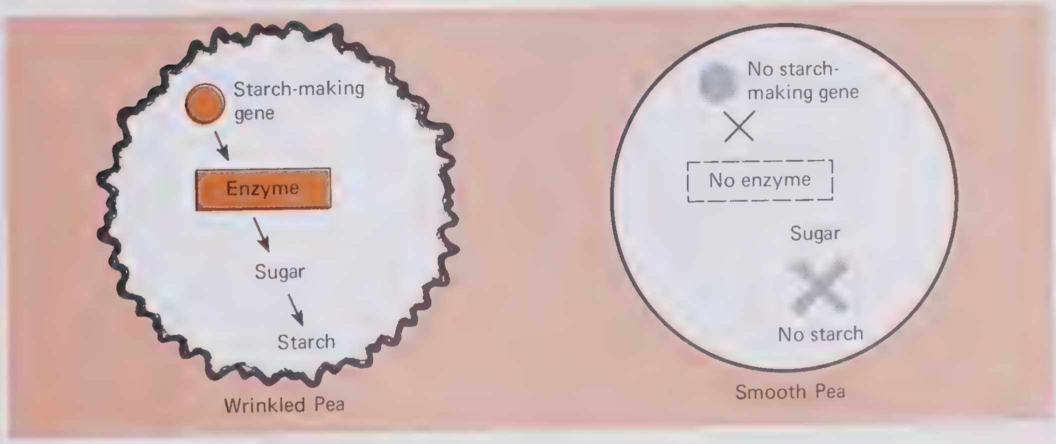


M

Hold the dish up to the light. Compare the 4 spots.

A. CHECKING ON THE GENES

5. Which spots contain starch?
6. Was the starch in the jelly? How do you know?
7. Was the starch in the iodine solution? How do you know?
8. Was the starch in the peas? How do you know?
9. Where did the starch come from? (HINT: Sugar and starch are chemical cousins, even though they test differently with iodine.)



Use these diagrams to help you answer questions about starch-making genes

Something that helps change one chemical into another is called an enzyme.

10. Which kind of pea has a starch-making enzyme?

Peas inherit the ability to make starch, or they inherit the lack of this ability.

11. Name one kind of gene found in smooth peas. Name one kind found in wrinkled peas.

B. GENES IN PEOPLE

You have just seen 2 genes at work in peas. The genes control an enzyme. The enzyme regulates a chemical change in the peas.

In our body there are over 10,000 different enzymes. These enzymes regulate many things that go on in us. The genes that we inherit control the enzymes. So it is the genes that give us our inherited features. Use what you have learned about genes to solve these GENE PUZZLES.

The Hair Color Puzzle

12. Why does Julie have blond hair?

Hair Color Genes

● = gene for dark hair

○ = gene for blond hair

Father

Father's genes ● ○

Mother

Mother's genes ● ○

Daughter Julie

Julie's genes ○ ○

THE EYE COLOR PUZZLE

José inherited one gene for blue eyes.

13. Why aren't his eyes blue?

Eye Color Genes

● = gene for dark eyes

○ = gene for blue eyes

José has dark eyes. He has an enzyme that makes melanin dye in his eyes.

José's genes ● ○

Carl has blue eyes. He doesn't have the enzyme, or the melanin dye.

Carl's genes ○ ○

THE EAR PUZZLE

14. What shape earlobes does Maybelle have?

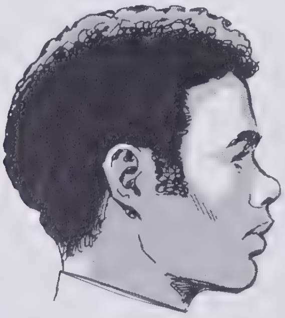
Ear Shape Genes

Ⓐ = gene for attached earlobes

Ⓕ = gene for free earlobes

Ⓕ is dominant

Father has attached earlobes.



Father's genes Ⓐ Ⓐ

Mother has free earlobes.

Mother's genes Ⓕ Ⓕ

Daughter Maybelle

Maybelle's genes ? ?

The Mixed Up Babies

15. Which baby belongs to the Levys?

Records on the Levys' new baby were mixed up in the hospital. Doctors used blood type genes to identify the Levy baby correctly.

Blood Type Genes

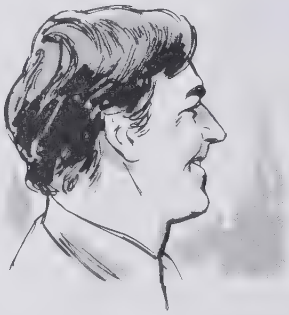
A = protein **A**

B = protein **B**

O = neither protein

Both A and B are dominant over O

Father Levy



Father's blood type **AB**

Mother Levy

Mother's blood type **AB**

Baby boy

Boy's blood type **A**

Baby boy

Boy's blood type **O**

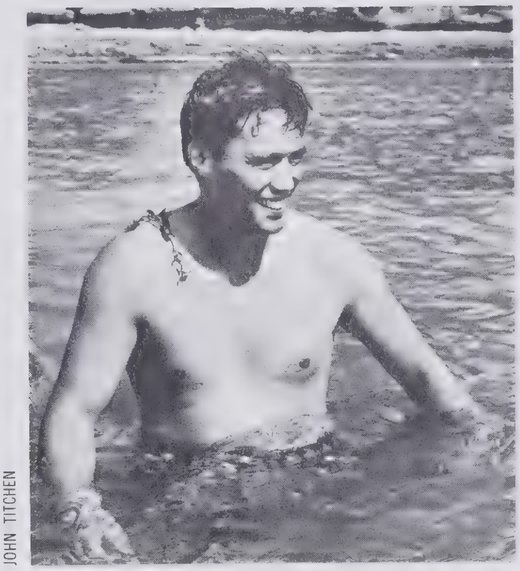
SELF TEST ANSWERS

This is how a scientist would answer the statements on page 348 (28).

1. False. The blood has nothing to do with inheritance.
2. True. However, a woman is protected from the baldness by her hormones.
3. Partly true. But many scientists believe that environment, or the conditions we live under, is equally important in regulating our intelligence.
4. True.
5. True. But identical twins are almost alike.
6. False; except in families that have certain hidden forms of inherited mental disease.
7. False. Nothing a pregnant woman sees can change the inheritance of the baby.
8. True.

13 WHERE ARE THE GENES?

This is a picture of a crack swimmer. His skin is a warm brown all over.


JOHN TITCHEN

1. Which of his cells probably contains color genes?

Arthur Ashe is a world champion tennis player. He is handsome and well proportioned. He has long arms and strong legs.

TIM CARLSON

2. Where are the genes that control Arthur's proportions?

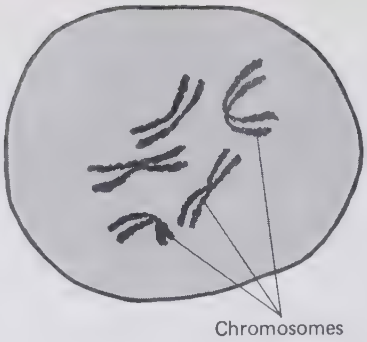
You know that:

Genes are passed from parent to offspring.

Genes control enzymes. Enzymes work to build inherited features.

Thus genes control inherited features. They control thousands of features besides growth and skin color.

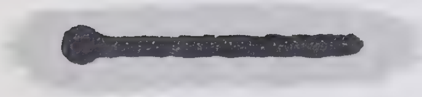
Scientists think that all cells in a living creature have the same genes. Where are the genes in a cell?



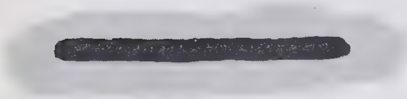
A. CHROMOSOMES AND GENES

Chromosomes are dark-staining rods or threads found in cells. Each plant or animal has a definite number of chromosomes in each of its cells.

The chromosomes contain the genes that control inheritance. We know this from experiments on corn.



In one experiment, chromosome No. 9 in the corn plants looked like this. Plants with this knobby chromosome always had dark-colored kernels.



In other corn plants the knob was missing. Chromosome No. 9 now looked like this. Those plants always had light-colored kernels.

3. In corn cells, where do you think the genes controlling kernel color are located?

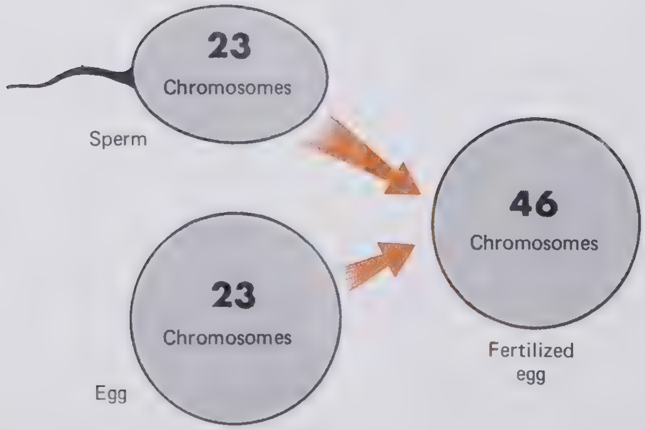
All the genes are located in chromosomes. Each chromosome in a cell contains a share of the cell's genes.

B. WHAT'S YOUR CHROMOSOME NUMBER?

4. From the table, how many chromosomes does each human cell normally have?

TABLE OF CHROMOSOME NUMBERS

Living Thing	Number of Chromosomes in Each Regular Cell
Human being	46
Frog	26
Dog	78
Corn plant	20
Onion plant	16



In humans 2 kinds of cells don't have the regular number of chromosomes. Each human egg or sperm cell has only 23 chromosomes.

When a new life starts, the egg and the sperm join to form a fertilized egg. The fertilized egg develops into a baby. It does this by dividing many times and forming many new cells.

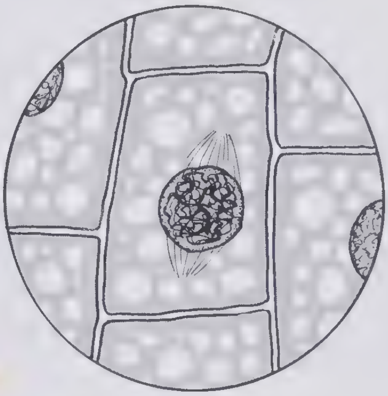
The fertilized egg has a full set of 46 chromosomes. It received half a set from the egg, and half a set from the sperm. The fertilized egg passes on a full set to each new cell that forms.

How does it do this? The CHROMOSOME ACTIVITY will show you.

CHROMOSOME ACTIVITY

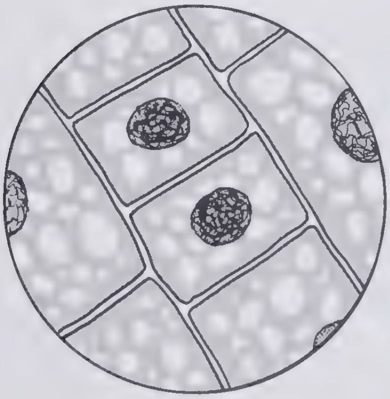
A

Get stained onion root slide. Near the tip of the root, find cells dividing to make new cells.



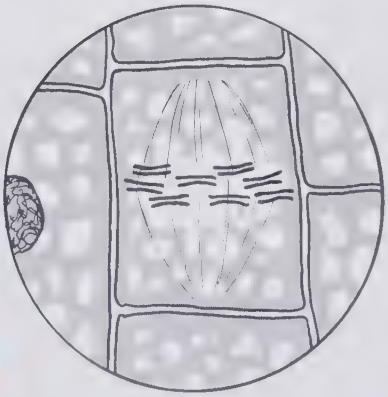
B

Find a cell with a dark round nucleus. In the nucleus the chromosomes are mixed together. They are busy making a duplicate set of chromosomes.



C

Find 2 smaller cells side by side. They come from a cell that has just divided. Each new cell has its full set of chromosomes.



D

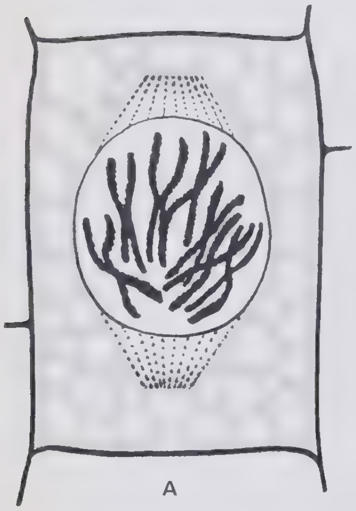
Try to find 2 full sets coming from one full set!

E

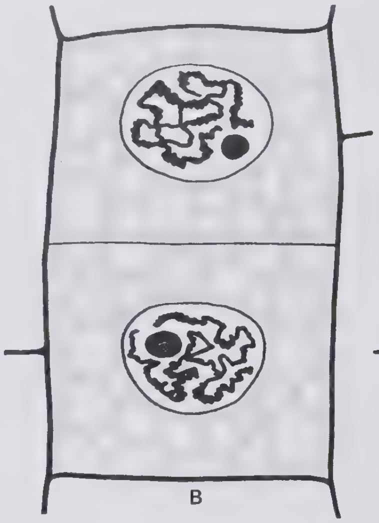
The CELL DIVISION WORKSHEET shows other stages in between ACTIVITY steps **C** and **D.** Try to find these stages. Then complete the worksheet.

Cell Division Worksheet

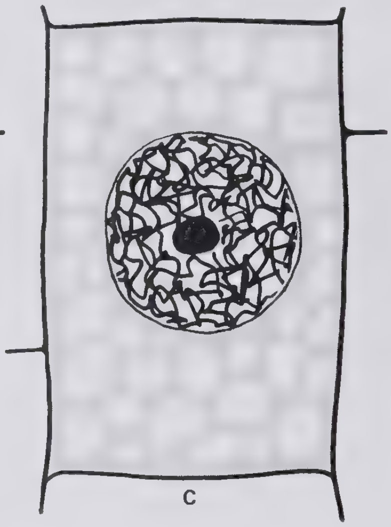
Illustrated below are the stages in cell division. However, the stages are not in the proper order. In your notes write what you think is the proper order. Then ask the teacher to check your notes.



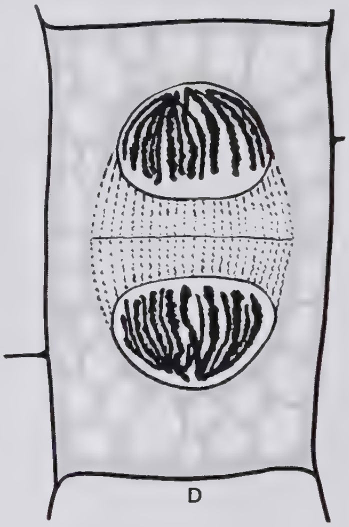
A



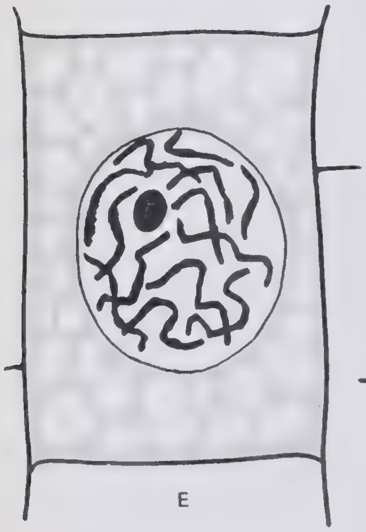
B



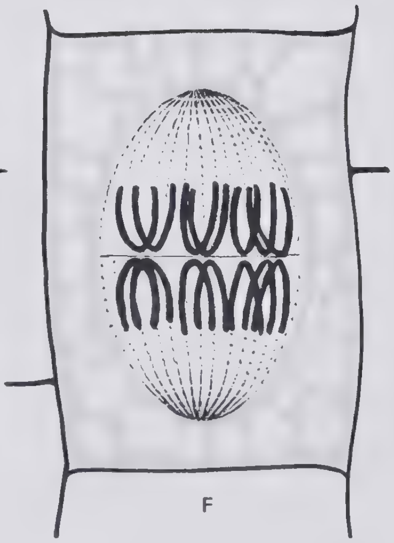
C



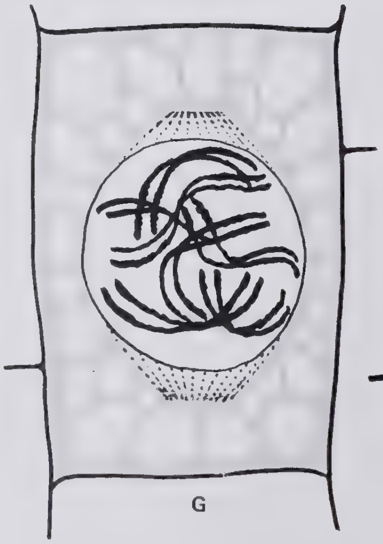
D



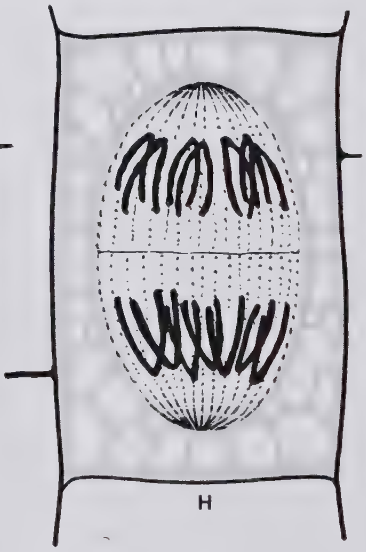
E



F



G



H

Answer the following in your notes.

5. Chromosomes contain the _____ which regulate heredity.
6. When a cell is ready to divide, the chromosomes have already _____.
7. First the nucleus of the cell _____.
8. The chromosomes gather in the _____.
9. One set of chromosomes goes to _____.
10. Each new cell gets a full set of _____ and a full set of _____.

14 IF THE CHROMOSOMES GO WRONG

word guide

mongolism

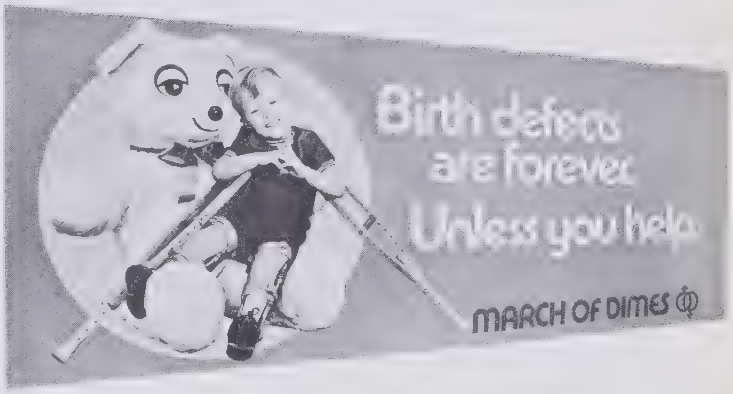
MONG-guhl-izm

One out of every 200 unborn babies has a serious genetic defect. Something is wrong or missing in its chromosomes or genes. Genetic defects are inherited.

Sometimes, an inherited defect prevents the brain from developing. Of course a baby cannot live without a brain.

Many babies with serious genetic defects die before birth, or shortly after. If they live, they are handicapped.

The babies don't have to die. The defect can often be prevented or treated. This depends on understanding the cause of the genetic defect.


Birth defects
are forever.
Unless you help.
MARCH OF DIMES

THE MARCH OF DIMES

A. GENE DEFECTS

Here are some conditions caused by defective genes:

PKU disease (black urine)
Bleeder's disease (hemophilia)
Undeveloped brain
Abnormally thick and rough skin
Inherited deafness
Certain mental defects

The defective genes are usually hidden in the parents. The genes may be passed on for generations without ever showing.

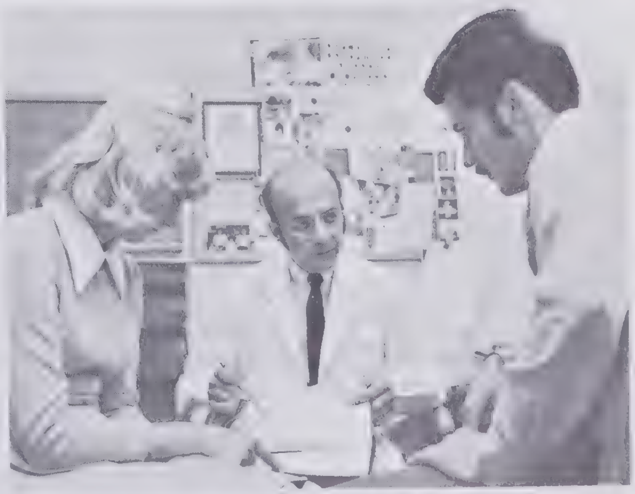
However, any time 2 people with the same defective gene marry, their children may show the defect.

B. GENETIC COUNSELING

Any couple who think they may carry a genetic defect can go to a genetic counselor.

The counselor has studied the genetics of tongue rolling and ear lobes, as well as animal and plant genetics. This training helps in giving advice on human genetic problems. The counselor will tell them what their chances are of having a defective baby.

The couple may decide not to have a baby. Instead, they can adopt a child.



THE MARCH OF DIMES

Couple with genetic counselor

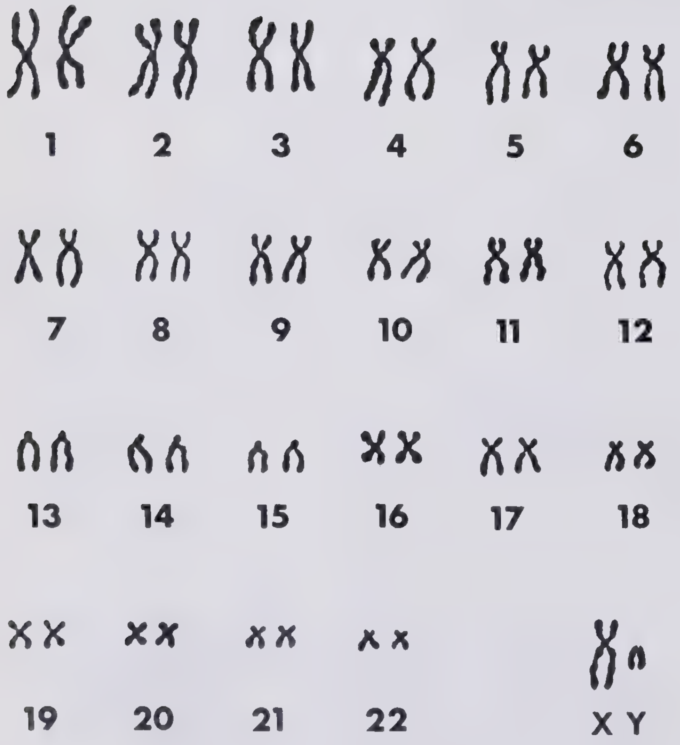
Or, if the defect can be treated, they may decide to have their baby. They will know beforehand that it is likely to be defective. They will know what to do.

For example, a blood or urine test at birth will show if the baby has PKU. Many states require such a test. A special diet can control PKU disease.

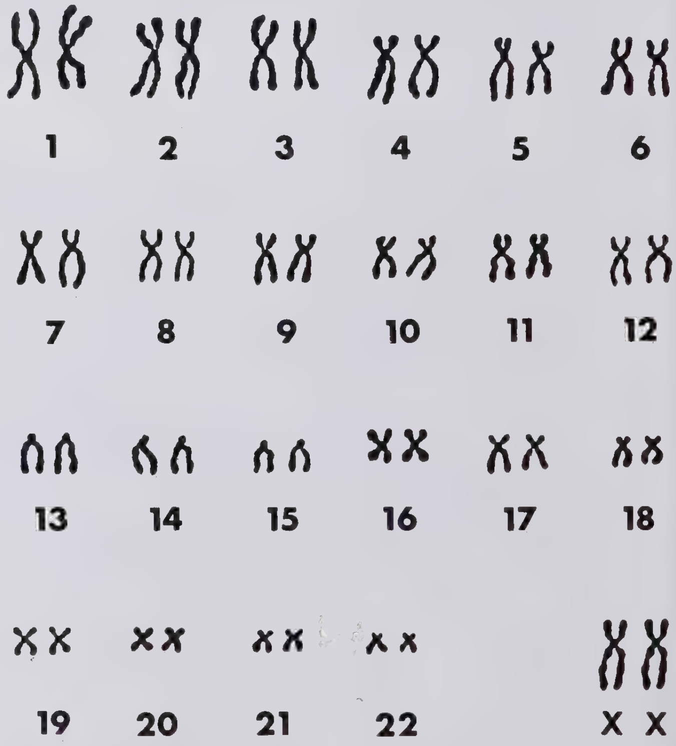
C. MATCH THE CHROMOSOMES

Suppose the defect is in the chromosomes. There may be an extra chromosome. Or, a chromosome may be missing.

Such a defect is easy to see. A lab technician draws some blood. The technician grows the white blood cells, stains them, and photographs the chromosomes. Then the chromosomes are matched against a normal set.



These are the chromosomes of a normal man.

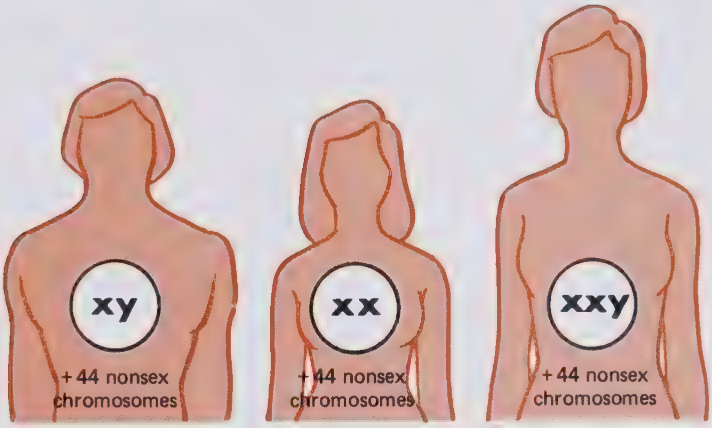


These are the normal female chromosomes.

1. What is the difference?

D. CHROMOSOME DEFECTS

Sometimes a baby is born with an unusual set of sex chromosomes, XXY. The baby grows up to be a man. He is always remarkably tall, sterile, and somewhat feminine in appearance. The extra X chromosome is responsible for these features.



Which chromosome set is unusual?

A person may have only one X sex chromosome and no Y. Such a person is a woman. She is very short, has immature sex organs, and is sterile.

The defect may also be in the nonsex chromosomes. An extra chromosome No. 21 (3 copies instead of 2) causes Down's disease or **mongolism.** When this is present, there are 47 chromosomes in each cell, instead of the normal 46.

Children with this condition have oriental-looking features. They are nice children, and often love music. But they are dull-witted. They are often short and they tend to die young.

E. PICK OUT THE SET

Below are 5 different sets of chromosomes, and the conditions they cause:

Chromosome Set	Total Number of Chromosomes in Each Cell	Condition
Sex chromosomes XY	46	Normal man
Sex chromosomes XX	46	Normal woman
Sex chromosomes XXY	47	Tall, sterile man
Sex chromosome X	45	Short, sterile woman
Extra chromosome No. 21	47	Mongoloid

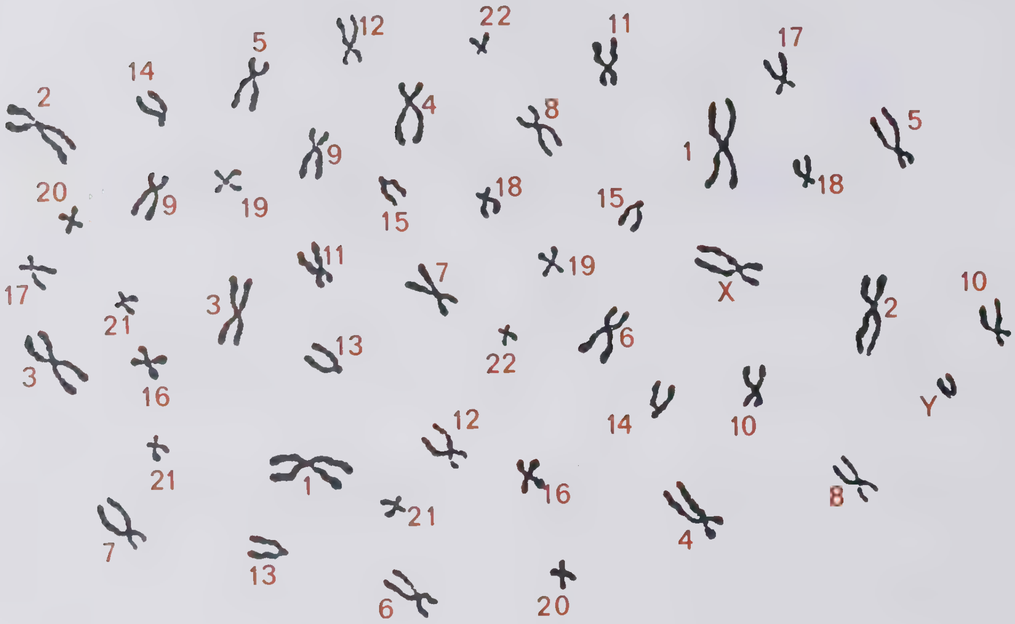
The CHROMOSOME SET WORKSHEET shows 2 of these sets. A genetic counselor has already numbered the chromosomes.

Pretend you are the assistant. Find out which chromosome sets the counselor found.

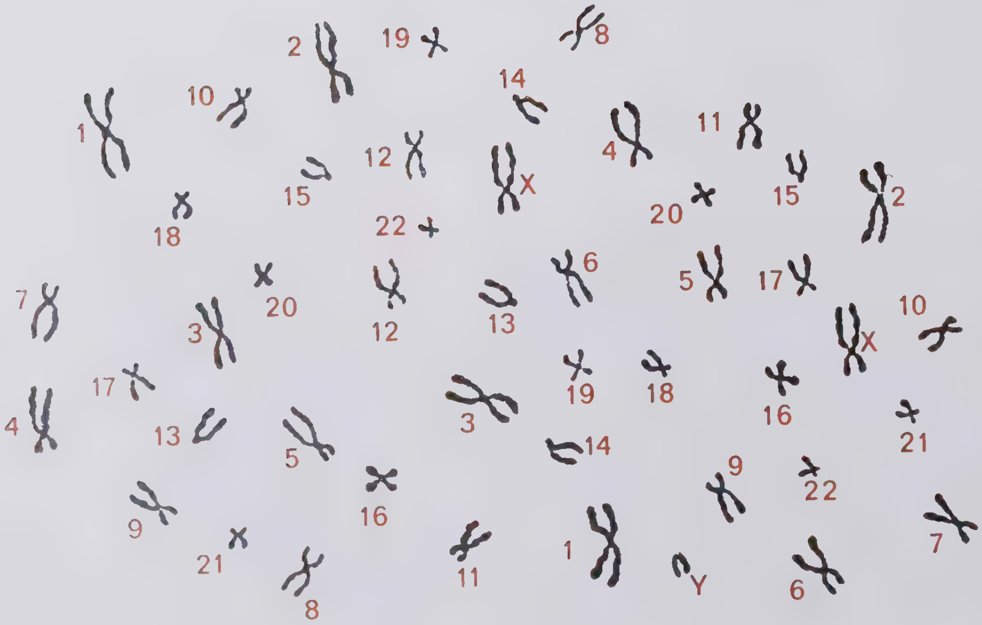
2. What condition does set A cause?
3. What condition does set B cause?

CHROMOSOME SET WORKSHEET

Set A



Set B



15 THE CODE OF LIFE

word guide

amino acid	*uh-MEE-noh AS-id*
glutamic acid	*gloo-TAM-ik AS-id*
proline	*PROH-leen*
sickle cell anemia	*SIK-l sel uh-NEE-mee-uh*

— •••• •/—•—• ——— —•• •/——— ••—•/
•—•• •• ••—• •

The sentence above is in radio code. The table will help you decode it.

RADIO CODE

•—	A	•———	J	•••	S
—•••	B	—•—	K	—	T
—•—•	C	•—••	L	••—	U
—••	D	——	M	•••—	V
•	E	—•	N	•——	W
••—•	F	———	O	—••—	X
——•	G	•——•	P	—•——	Y
••••	H	——•—	Q	——••	Z
••	I	•—•	R		

Write some messages in radio code.

A. WE USE CODES

Probably some of the words you wrote were short and some were long. But all were made from the same alphabet.

1. How many letters does the radio code alphabet have?

Here is another simple code. It is used to label airport baggage. It makes sure that each suitcase is shipped to the right airport.

The radio code and the airport code use the same alphabet.

2. What difference is there between words written in the 2 codes?

AIRPORT CODE

Code Word	Airport
BOS	Boston
DAL	Dallas
JFK	Kennedy Airport, New York
LAX	Los Angeles
OKC	Oklahoma City
ORD	O'Hare Airport, Chicago
SJU	San Juan, Puerto Rico
STL	St. Louis
YUL	Montreal, Canada
YYZ	Toronto, Canada

B. THE COLOR OF BLOOD

ORIGINALLY PUBLISHED: MCDONALD, L. W. AND HAYES, T. L., EXPERIMENTAL AND MOLECULAR PATHOLOGY, 10, 186, 1969. SEE ALSO SCIENTIFIC AMERICAN, EVERHART, T. E. AND HAYES, T. L., 226, 54, 1972.

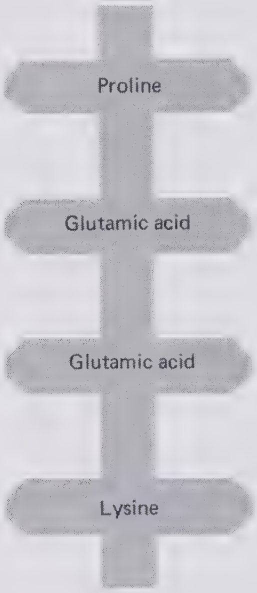
Red blood cells

You see that codes carry messages. Codes can also direct traffic.

In all cells there is a code of life or genetic code. The genetic code carries messages and directs traffic. In doing so it controls inheritance. Let's see how it works.

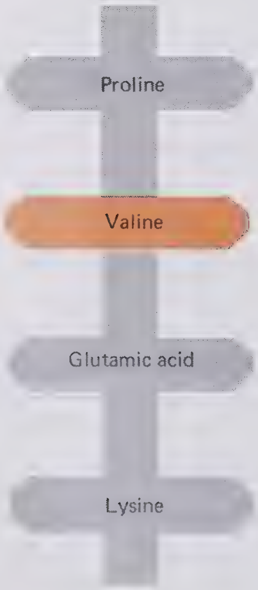
Bill Johnson has **sickle cell anemia.** He is weak. He may die in early childhood. His hemoglobin doesn't work right.

Hemoglobin gives red blood cells their color. It helps these cells carry oxygen. Thus it helps keep us alive.



Hemoglobin is a protein. Like all proteins, it is made of a string of smaller molecules, or chemical units, called **amino acids.**

This is part of a normal hemoglobin protein. Only 4 of the amino acids that make up the protein are shown. There are many more.



This is the same part of Bill Johnson's hemoglobin.

3. What is wrong with Bill's hemoglobin?

C. THE GENETIC CODE

Bill has the wrong kind of hemoglobin because he inherited a mistake in his genetic code.

The genetic code uses a 4-letter alphabet: A, C, G, and either U or T. The letters stand for certain chemicals that join together to form genetic codewords. Each codeword has 3 chemical letters.

SELECTED GENETIC CODE

Amino Acid	Codeword
Glutamic acid	GAA
Lysine	AAA
Proline	CCA
Valine	GUA

This is how a cell uses the genetic code to make hemoglobin.

The codeword CCA latches on to a molecule of the amino acid **proline.** It carries the proline to the place in the cell where the hemoglobin is being made.

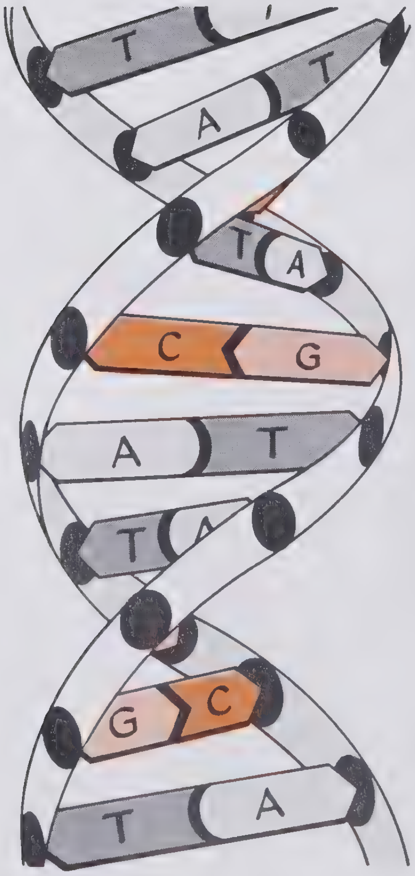
The codeword GAA brings another amino acid, **glutamic acid.** The GAA drops off its glutamic acid at just the right spot in the growing hemoglobin molecule. This continues until the whole string is finished.

4. Write the codewords for the 4 amino acids shown in normal hemoglobin.
5. What is the mistake in Bill Johnson's genetic code?

D. SO WHAT'S A GENE?

All the codewords for hemoglobin are strung together in a sentence. The coded sentence is a gene. It is part of a chromosome.

There are genes or coded sentences for all the materials that the body makes. When parents pass on chromosomes and genes to their children, they are passing on their heredity in code.



Part of a DNA molecule

E. DNA CARRIES THE CODE

Genes, the genetic code, and the codewords are real. But where are they in the chromosomes?

The chemical letters A, C, G, T are part of a molecule called DNA. DNA is found in the chromosomes. DNA is a large molecule with a long chemical backbone.

The chemical letters that spell out the code are attached to the backbone. The order of letters in this sentence spells out a message. The order in which the chemical letters line up also spells out a message.

However, this is only half of the DNA molecule. There is another half, built exactly the same way. The 2 halves face each other, like someone looking in a mirror.

In fact, the 2 halves are mirror images of each other. They both carry the genetic code. But where one side of the DNA molecule has an A, the other side has a T. The A and the T are connected. Similarly, C on one side is connected to G on the other.

This is a model of part of a DNA molecule, or gene. It forms a kind of twisted ladder.

F. BUILDING A DNA MODEL

Are you confused? No sweat. You can build a DNA model. As you build it, you will come to understand it better.

You need a meter-long (yard-long) string, some toothpicks, a small pile of Cheerios, and some soda straws. The straws should be white and 4 colors. The colors stand for the 4 letters of the genetic alphabet. So, you will also need a private key, like this, to tell what each color means.

Chemical	Color
A	
C	
G	
T	

Ready? Do the DNA-MODEL ACTIVITY.

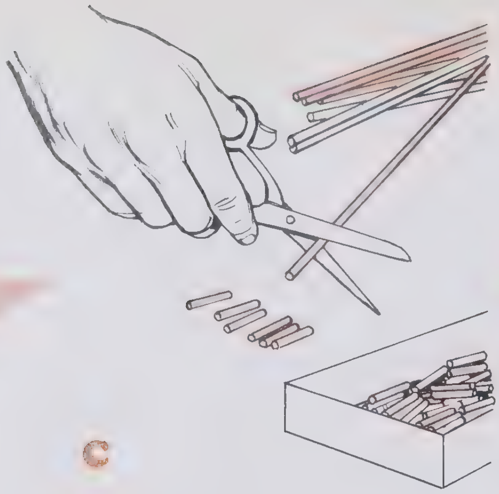
DNA-MODEL ACTIVITY

A

Collect materials. Fasten 2 rings to ringstand.

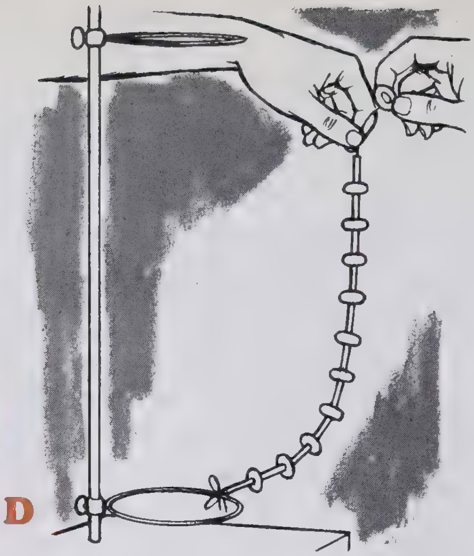
B

After cutting the meter-long string in half, tie the strings to bottom ring one toothpick apart.



C

Cut your straws into 2-cm (one-inch) lengths.



D

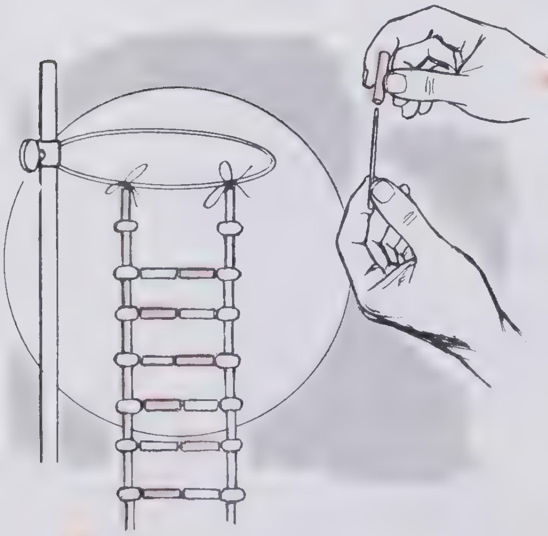
Starting at the bottom, string white straws and Cheerios alternately on one string.

E

Tie completed string to top ring. This is the backbone of DNA molecule.

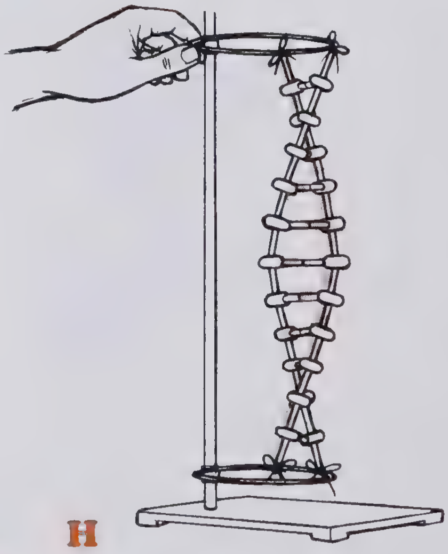
F

Do second string the same way.



G

Put 2 different-colored straws on a toothpick. (Remember your private key!) Stick the toothpick into 2 opposite Cheerios.



H

Unfasten top ring from ringstand. Give it a twist. Refasten it. Your model is now complete.

REPRODUCTION

CONTENTS

REPRODUCTION

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1 THE FUTURE FATHER

Look at the dance scene below. It's a swinging affair. The boys and girls are certainly interested in each other.

word guide

adolescence	*ad-uh-LES-uhns*
intercourse	*IN-tuhr-kawrs*
penis	*PEE-nuhs*
prostate	*PROS-tayt*
reproduction	*ree-pruh-DUK-shuhn*
scrotum	*SKROH-tuhm*
semen	*SEE-muhn*
sexual	*SEK-shoo-uhl*
testes	*TES-tees*

Their interest is part of the powerful sex drive. This drive can be a wonderful experience. It can also do great harm. A lot depends on understanding and learning how to manage it.

The developing sex drive is preparation for **reproduction.**

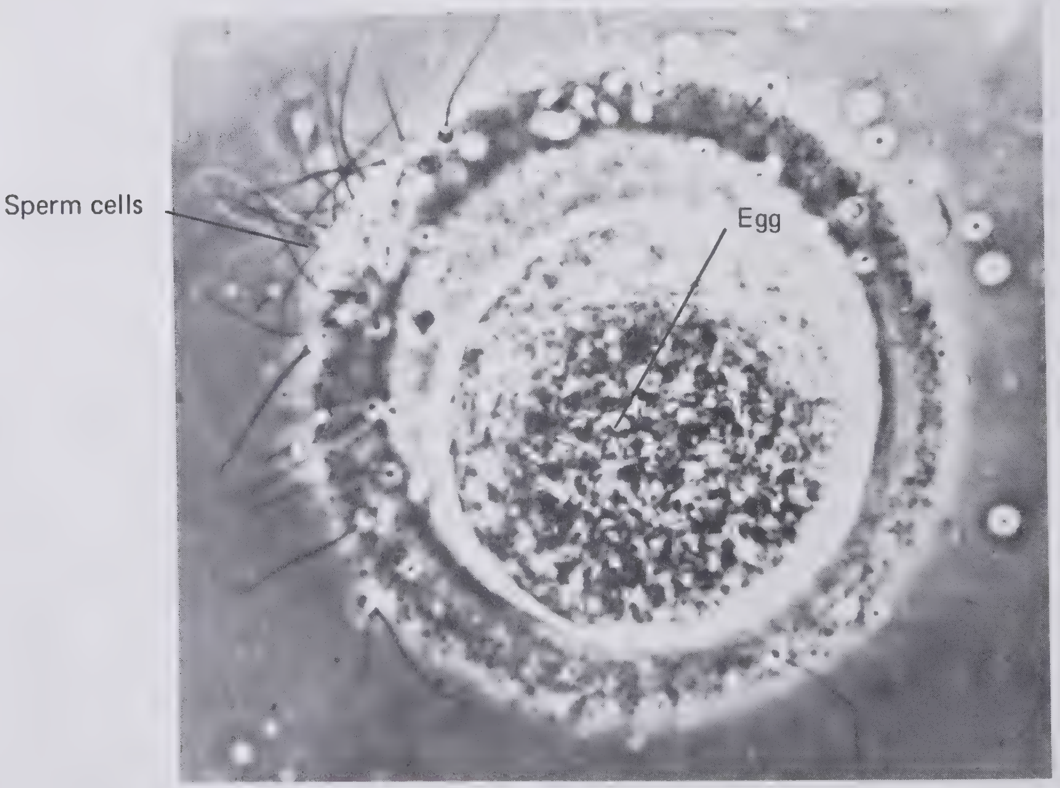
A. EGG AND SPERM

A human baby comes from an egg. Nobody sees the egg. It is microscopic, and it stays in the mother's body. Once a month a mature woman or girl releases an egg within her body.

The egg can develop into a baby only after it is joined with a sperm cell. The father supplies the sperm. Because there must be two parents, male and female, human reproduction is **sexual.**

COURTESY OF DR. LANDRUM B. SHETTLES

Sperm cells



COURTESY OF DR. LANDRUM B. SHETTLES

Human egg cell with several sperm cells

A man makes sperm cells continually. Let's see how.

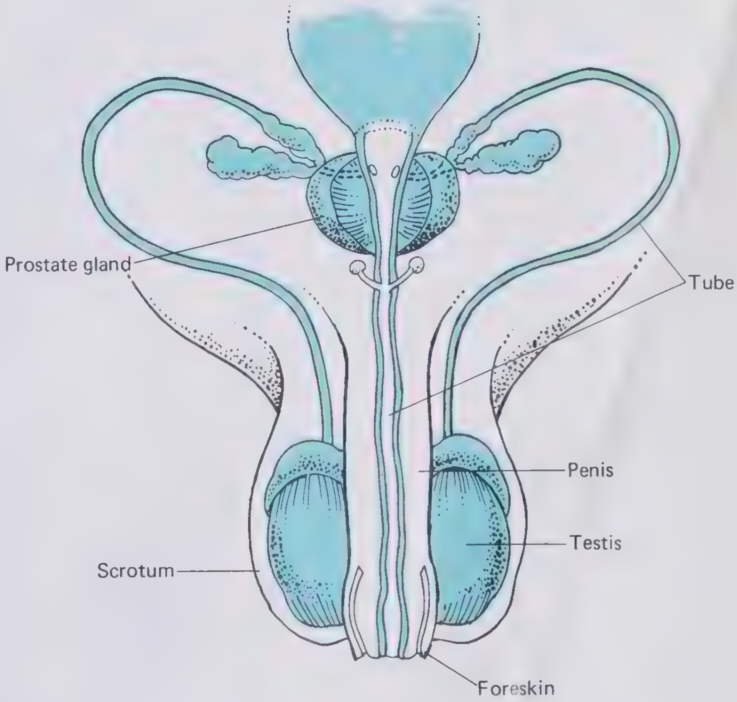
B. THE MAN MAKES SPERM

Look at the drawing of the male reproductive system. The **testes** (plural of testis) are held outside the body in a sac called the **scrotum.**

Each day, beginning in **adolescence,** the testes make millions of sperm cells. Each sperm has a tail. The sperm swim in a liquid called **semen.**

Glands make the semen. The biggest of these glands is the **prostate.**

The semen, with its sperm cells, flows along a tube into the **penis.** The tube carries urine and semen into the penis, but not both at the same time.



C. WHERE THE SPERM GOES

Semen is made all the time but it doesn't flow all the time. Sometimes at night it overflows. This overflow, sometimes called a wet dream, is normal.

For reproduction, semen and sperm have to be transferred to the female. The penis makes this transfer during **intercourse.** Sexual excitement causes blood to fill the penis and make it firm and erect. Then the penis can be placed in the woman's body. The semen is released.

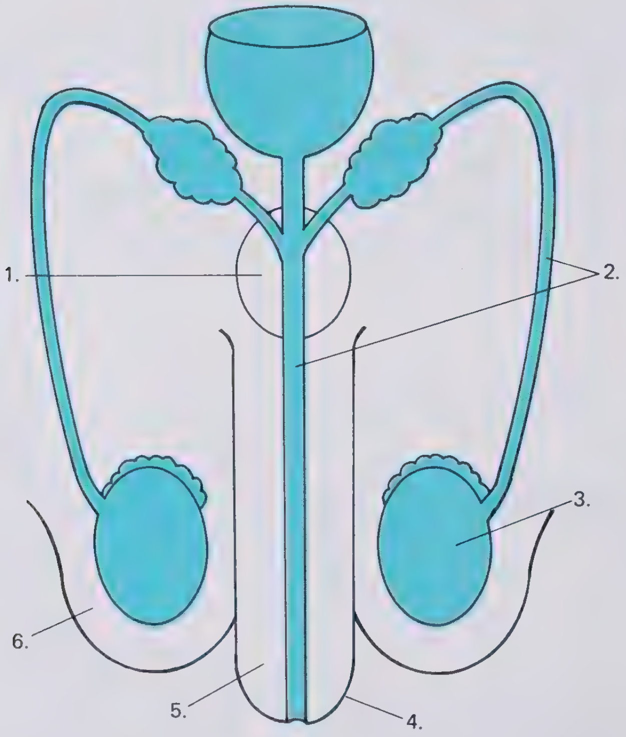
A young boy's reproductive organs are small and undeveloped. During adolescence they grow in preparation for reproduction.

D. ADDING IT ALL UP

Young people have a natural interest in sex and reproduction. They have many ideas and opinions on these subjects. Discuss the following with your group:

1. Some people think that this lesson and similar lessons should not be taught in school. What does your group think?
2. Many people think that our advertisements, magazines, and entertainment are too sexually stimulating. What do you think?
3. Is a young person who is physically ready for reproduction ready for marriage and parenthood?

To help you remember what you have learned, look at this diagram. On a separate sheet of paper, name each of the numbered parts. Use the drawing on the previous page as a guide.



In your notes, complete the following statements:

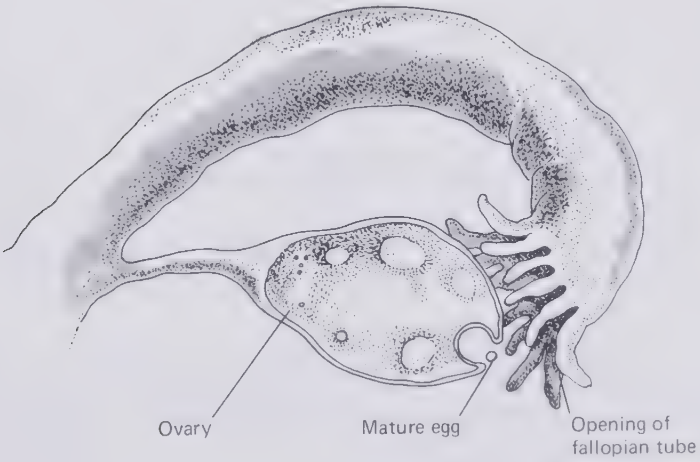
4. Sperm are made in the ____.
5. The sperm travel through the ____ to the ____ gland.
6. This gland adds ____ to the sperm cells.

2 THE FUTURE MOTHER

word guide

abortion
uh-BAWR-shuhn
Fallopian
fuh-LOH-pee-uhn
menstruation
men-stroo-AY-shuhn
ovary
OH-vuhr-ee
ovulation
ov-yoo-LAY-shuhn
sterilization
ster-uh-luh-ZAY-shuhn
vagina
vuh-JY-nuh
womb
WOOM

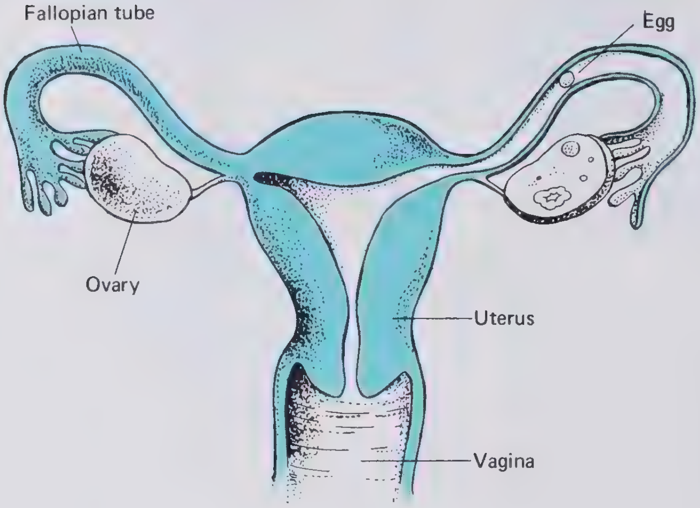
A woman has 2 **ovaries.** The ovaries alternate in releasing eggs. Between them they release one egg each month. Releasing an egg is called **ovulation.**



At ovulation, the egg pops into the opening of the nearby **Fallopian** tube. The egg drifts down the tube. In about 4 days it arrives in the uterus.

This wonderful structure is also called the **womb.** Its outer walls are strong and muscular. Its inner lining can shelter the egg and the baby.

While the egg drifts down the tube, the uterus prepares to receive it. The lining of the uterus grows soft and thick, like a comfortable blanket. Many new blood vessels develop.



A. MENSTRUATION

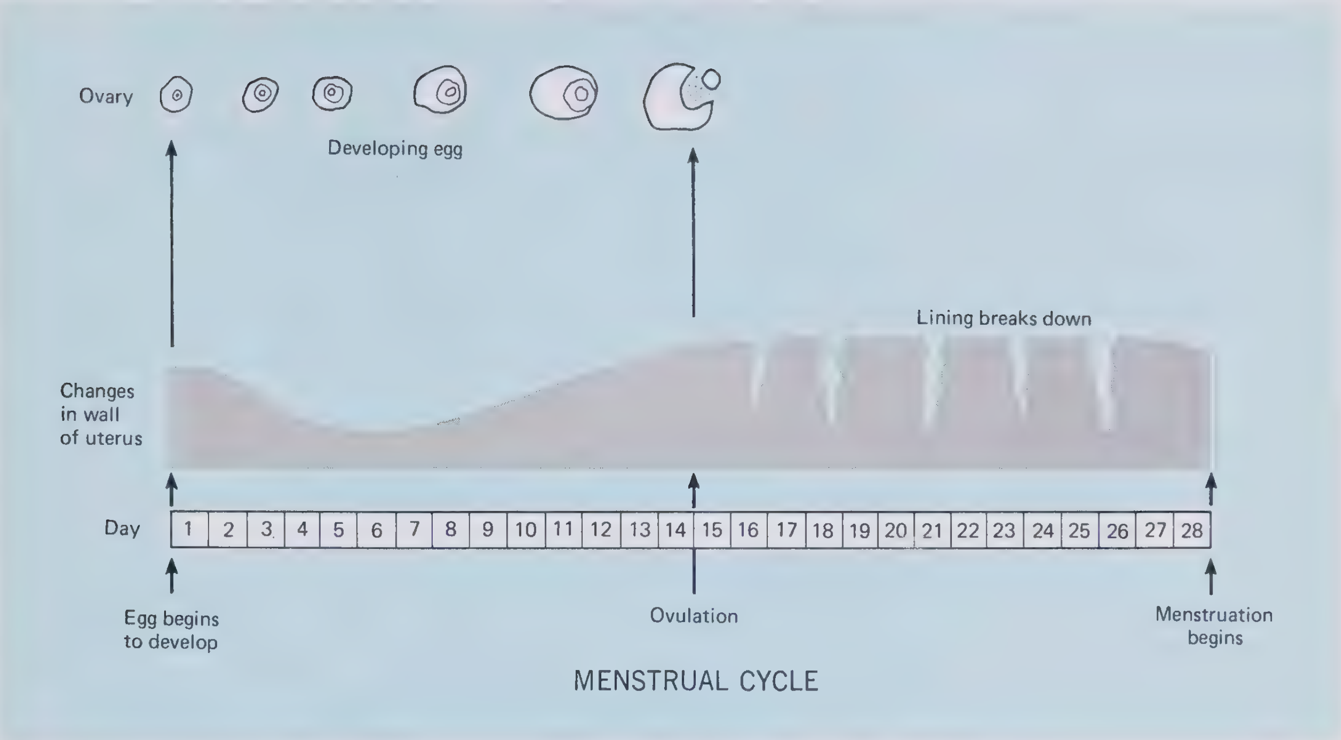
If the egg doesn't join with a sperm before it reaches the uterus, it dies and breaks down.

Then the lining of the uterus breaks down too. Its cells are shed from the body through the **vagina,** along with blood from broken vessels. A woman calls this flow her period or **menstruation.**

Menstruation occurs about once a month. It takes place about 2 weeks after the **ovary** releases an egg. The flow usually lasts anywhere from 4 to 7 days.

About 2 weeks after the beginning of menstruation, another egg is released. So the average menstrual cycle, from one ovulation to the next, is about 28 days. However, it is not unusual for the cycle to be a few days longer or shorter.

Menstruation ends when a woman is in her 40's or 50's. She may continue to have a normal sex life. She can no longer have children, however, because her ovaries have stopped releasing eggs.



1. What is ovulation?
2. Complete the following sentences in your notes. Eggs are made in the ____. The eggs travel down the ____ tube into the ____.
3. What happens if an egg does not join with a sperm?
4. What is menstruation?
5. Can you trace the menstrual cycle in the diagram?

B. FAMILY PLANNING

Many people are concerned about the explosive growth of world population. They think we can best control the people bomb by making it possible to plan the size of our families.

There are various ways for a couple to determine when they will have a baby and when they will not. The pill contains chemicals called female sex hormones. These are discussed in chapter 5. The hormones stop ovulation.

There are chemical and mechanical ways for keeping the egg and the sperm cells apart during intercourse. The rhythm method has the same effect. This tells a woman the days of the month when she is probably not fertile.

Some states allow **sterilization.** This means blocking the tubes which carry the egg or sperm cells out of the body. As far as we know, there are no harmful effects. However, sterilization is usually permanent.

The United States Supreme Court has ruled that **abortion** is legal during the first 3 months of pregnancy. In special cases it may sometimes be permitted after 3 months. Abortion ends the pregnancy.

These methods are not approved by everyone. There are possible health dangers connected with the use of some. Yet in several countries, including ours, family planning has cut the birth rate and slowed population growth.

C. REPRODUCTION WORD GAME

Some of the words you have been reading may be unfamiliar. But they all are perfectly good words. Try using them in the REPRODUCTION WORD GAME. Here are the rules:

1. From 2 to 6 may play.
2. Use alphabet cards. You will need the following:

a — 15
b — 5
c — 15
d — 5
e — 35
f — 5
g — 5
h — 5
i — 25
j — 5
k — 5
l — 10
m — 15
n — 25
o — 25
p — 10
q — 0
r — 20
s — 25
t — 25
u — 15
v — 5
w — 5
x — 5
y — 5
z — 5

3. Put the cards in a jar or box. Shake them. Have each player draw one card. The player who draws the letter nearest the beginning of the alphabet plays first.
4. Put all the cards back in the container. Shake them. Dump them out on the table. Use only the letters that are face up.
5. A player has one minute to form as many words as possible from this list:

egg
erection
Fallopian tube
intercourse
menstruation
ovary
ovulation
penis
prostate
reproduction
scrotum
sex
sperm
sperm tube
testis
uterus
vagina
womb

6. Count the number of letters used. Keep score.
7. Put the cards back in the container and shake. The next player takes a turn.
8. Go around as many times as desired.
9. At the end of the game, the player who has used the most letters wins.

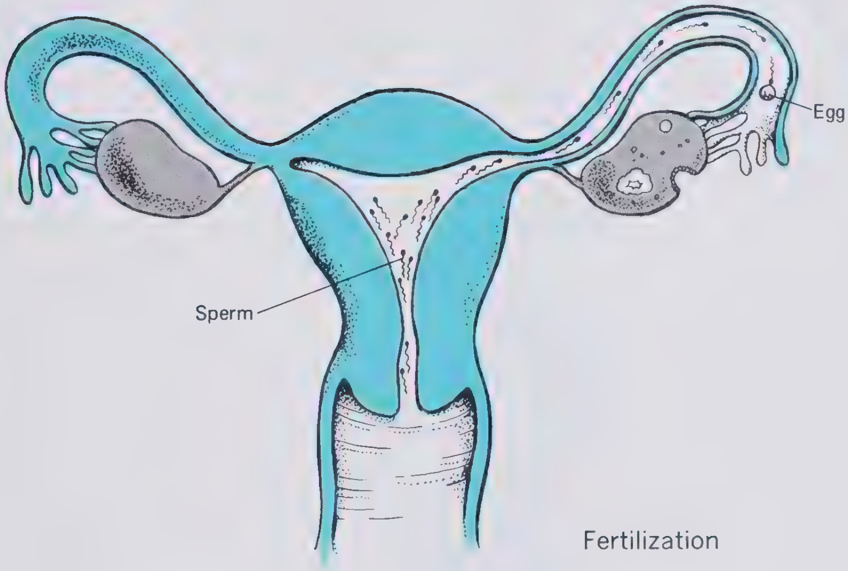
3 THE BABY COMES

Suppose sperm have been placed in the woman's vagina. They swim through the uterus and into the tubes.

If an egg is moving down one of the tubes, many sperm will probably reach it. One sperm will join or **fertilize** the egg. This is called internal fertilization. It takes place inside the body.

word guide

amnion	*AM-nee-uhn*
embryo	*EM-bree-oh*
fertilize	*FUHR-ti-lyz*
placenta	*pluh-SEN-tuh*



Fertilization

A. THE BABY MAKES A HOME

The baby develops internally also. Let's see how.

When the fertilized egg reaches the uterus, it settles in the soft lining. Menstruation does not take place. Instead, pregnancy has begun.

In the uterus, the fertilized egg is fed by the mother's blood. The egg divides into many cells. It grows quickly into an **embryo** or developing baby.

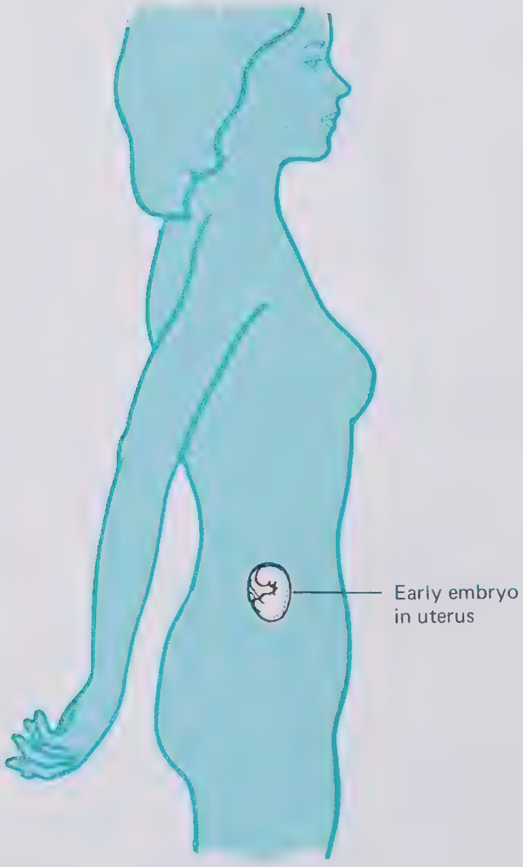
B. THE BABY'S LIFE LINE

Soon the embryo is too big to be fed directly by the mother's blood. It then makes its own blood.

It also makes blood vessels that run to the wall of the uterus. Through these blood vessels the embryo draws food and oxygen from the mother's blood vessels. Usually the baby's blood and the mother's blood do not mix.

The place where the embryo's blood vessels meet the mother's blood vessels is called the **placenta.** A cord connects the placenta with the baby's navel or belly button.

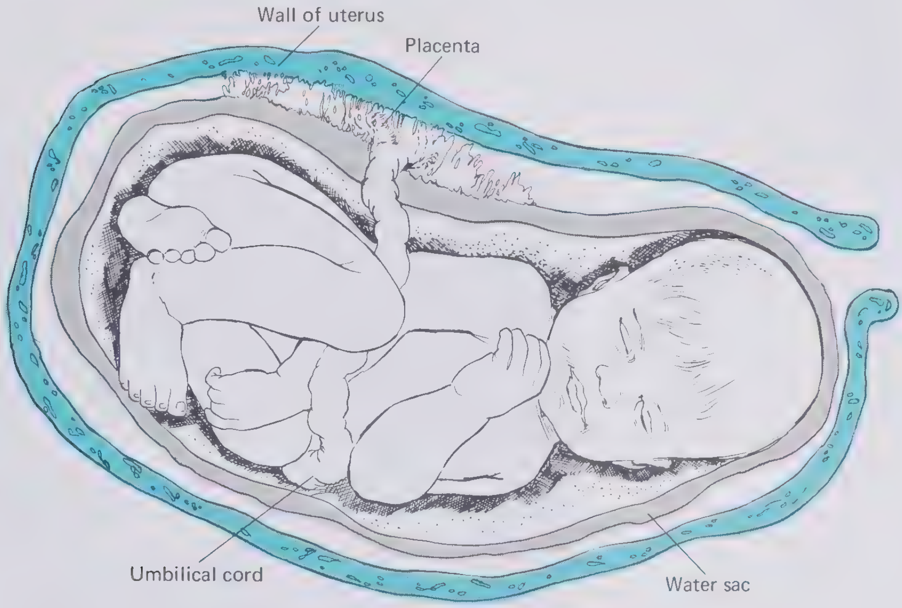
The embryo doesn't breathe or eat for itself, or get rid of its own wastes. Blood flowing through the cord takes care of all these needs.



A bag filled with water grows around the embryo. The technical name for this bag is **amnion.** The developing baby floats inside.

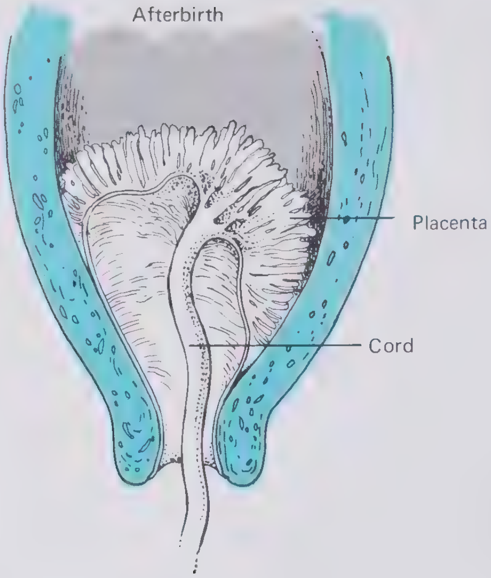
C. ENTERING THE WORLD

At the end of about 9 months the baby is ready to be born. It usually lies head down in the womb.



The muscles of the uterus squeeze and break the amnion. The water flows out. The contracting uterus slowly pushes the baby through the vagina or birth canal. When this happens the mother is said to be in labor.

The doctor receives the baby. The baby cries and starts breathing.



The doctor cuts the cord. The placenta and the stub of the cord are forced out of the birth canal. They are called the afterbirth.

PHOTO BY BRADFORD HERZOG,
COURTESY OF BOSTON HOSPITAL FOR WOMEN

Meanwhile the baby is cleaned and wrapped. Soon it will start nursing. A new human life is on its way.

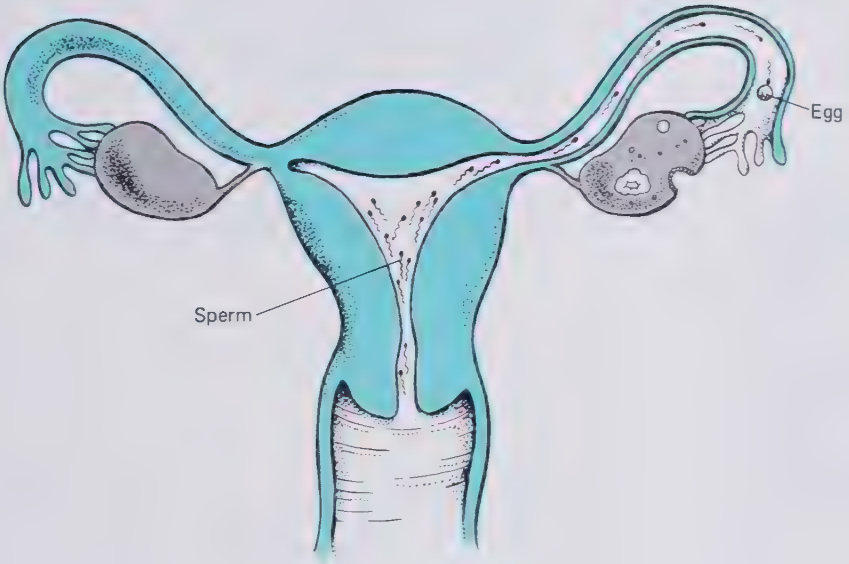
The birth of a baby is a thrilling event. Can you answer the following questions?

1. What makes a woman first suspect she is pregnant?
2. Why doesn't the baby drown inside the amnion?
3. How does the mother know that the baby is about to be born?
4. What is the "cord"? The "navel"? The "afterbirth"?
5. What other questions do you have about the story of birth?

4 PICTURE STORY OF DEVELOPMENT

word guide

incubator	*IN-kyoo-bay-tuhr*
navel	*NAY-vuhl*

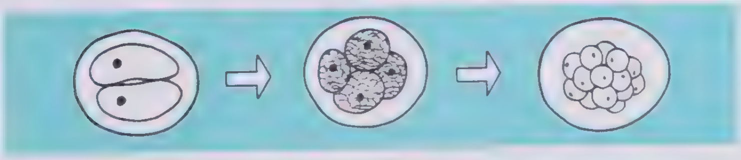


A human egg is fertilized. A new life begins.

Nine months later the baby is born. Let's see what happens during those 9 months.

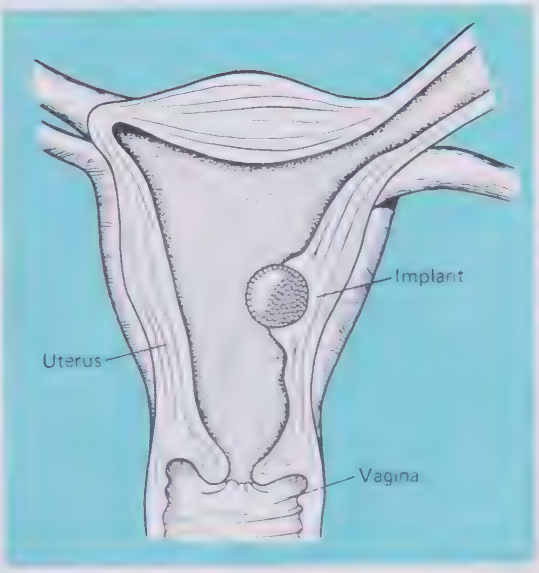
A. THE FIRST MONTH

As the fertilized egg moves down the tube, it splits. First, it splits into 2 cells, then into 4, 8, 16, and so on until there are many.

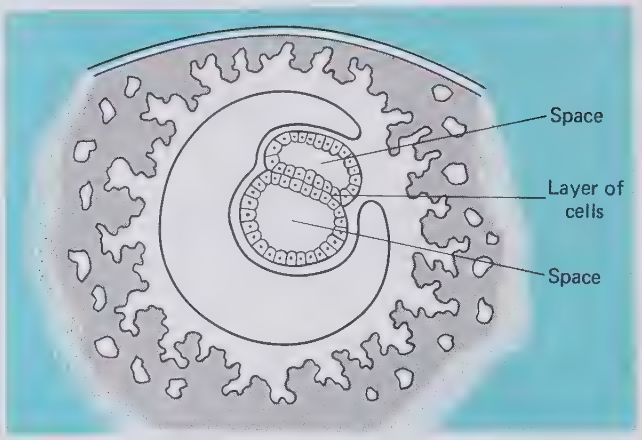


These cells form a ball. The ball of cells, or the young embryo, reaches the uterus.

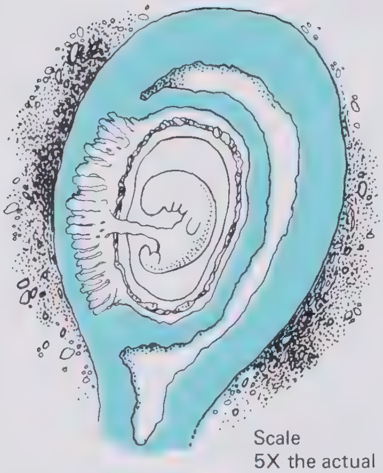
The embryo produces chemicals. These chemicals partly eat away the wall of the uterus. The embryo burrows into the wall and seems to disappear.



However, the hidden embryo is busy growing. Two spaces develop within it.



Look at the layer of cells between the spaces. This layer will become the baby. The rest of the ball of cells forms the amnion, placenta, and other protecting membranes.



The layer of cells grows and changes shape. It forms a beating heart and a brain. It grows a tiny tail. The backbone develops. Arms and legs are just buds. At this stage there are no eyes, nose, and ears.

B. THE SECOND MONTH

The cord grows between the baby's **navel** or belly button, and the placenta. The cord brings nourishment to the baby and carries away its body wastes.

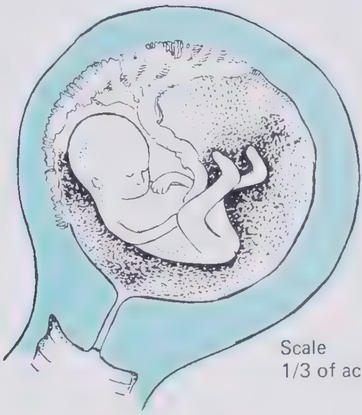
The face now takes shape, but the eyes are sealed shut. The arms and legs grow rapidly.

By the end of the month the tail normally disappears. Once in a great while a baby is born with the tail still visible.

DR. PAUL POPENCE, AMERICAN INSTITUTE FOR FAMILY RELATIONS

C. THE THIRD MONTH

The baby has grown to weigh almost 30 grams (1 ounce). It has arms, hands, fingers, legs, feet, and toes. The nails are just appearing. The ears start forming.

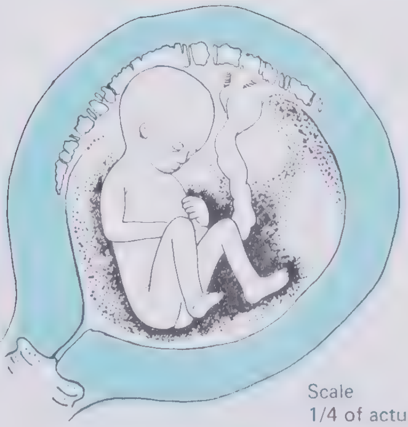


D. THE FOURTH MONTH

The baby's head is very large compared to the body. The ears, eyes, eyebrows, nose, and mouth are well along in development.

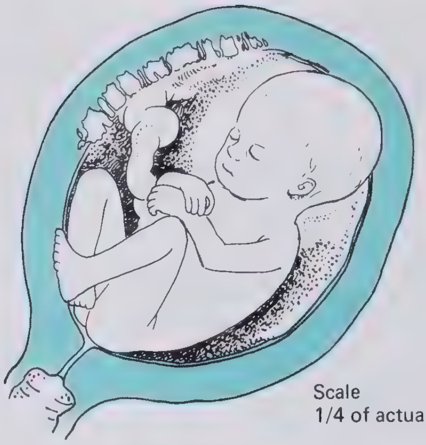
The skin is pink, transparent, and covered with fine hair. The baby's bones are visible through the skin.

The baby now weighs about 110 grams (4 ounces). It has grown over a hundred times in weight in 2 months. With its protective membranes, it fills the uterus and blocks the opening. The mother begins to look pregnant.



E. THE FIFTH MONTH

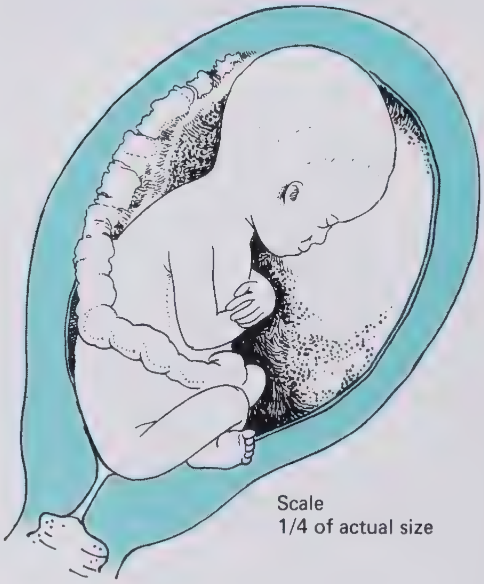
Hair is growing on the baby's head. The mother can feel the baby moving. Its muscles have developed.

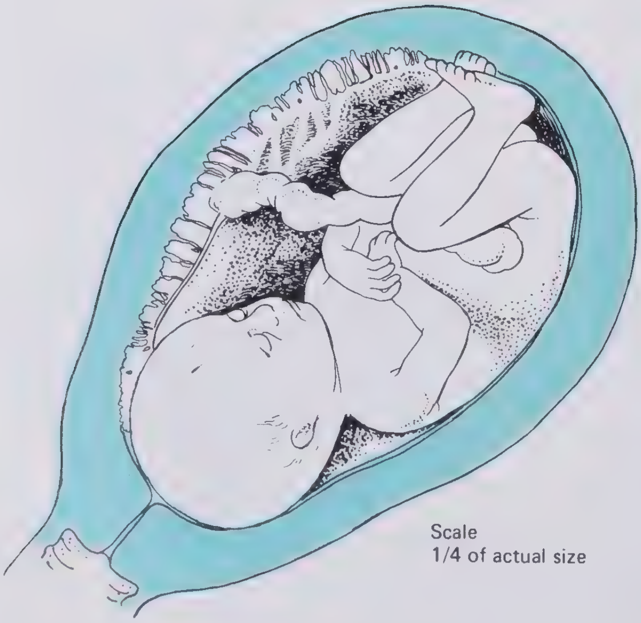


F. THE SIXTH MONTH

The baby's skin is wrinkled because there is very little fat under it. Later, when fat develops, the baby will become plump, and the wrinkles will smooth out.

The fingernails are growing. The eyes can open and eyelashes have appeared.

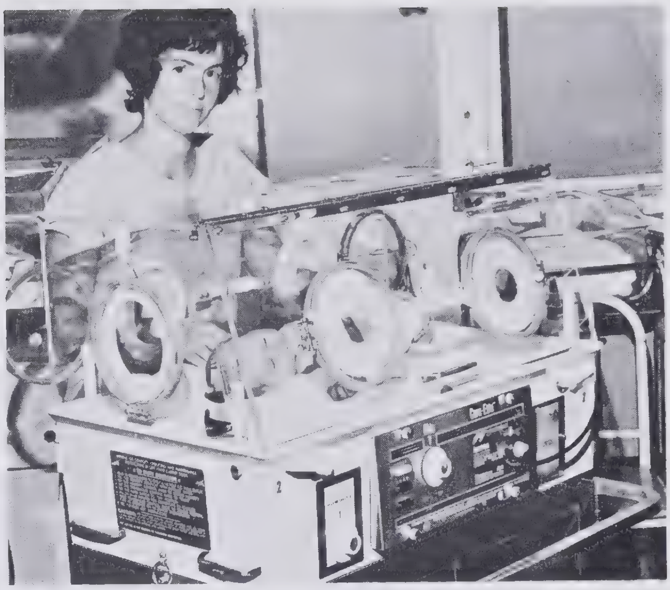




G. THE SEVENTH MONTH

The baby is still wrinkled and red.

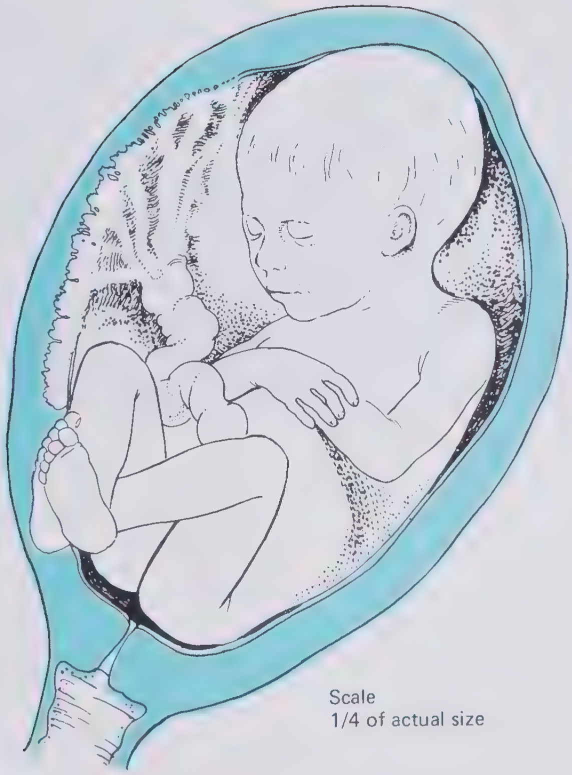
A baby born in the 7th month may survive. An **incubator** keeps it warm and provides other special care.



COURTESY OF BOSTON HOSPITAL FOR WOMEN

H. THE EIGHTH MONTH

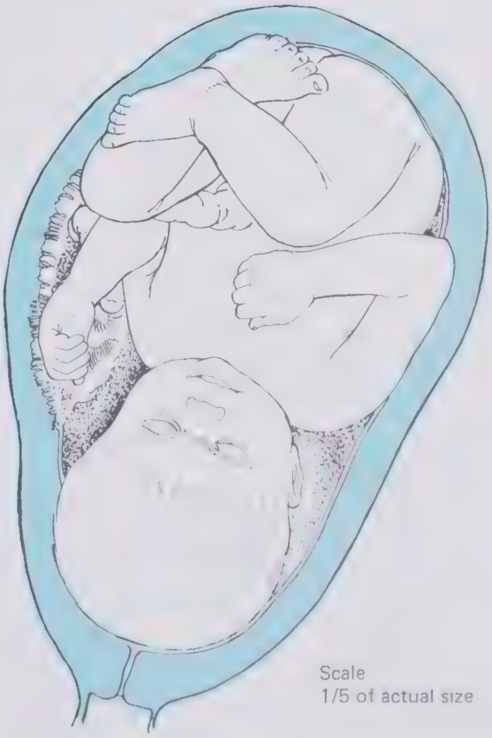
During the 8th month the baby's weight almost doubles. Its bones are still soft. An 8-month baby has a good chance of surviving outside the mother's body.



Scale
1/4 of actual size

I. THE NINTH MONTH, AND THE STORY ENDS

The fine coat of hair has disappeared from the body. The baby is ready to be born. Careful, don't press on a newborn baby's head! There are still soft spots between the skull bones.



Scale
1/5 of actual size

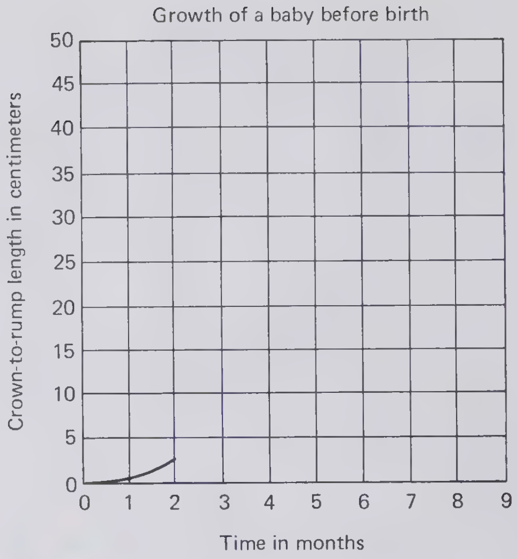
MEASURE-THE-BABY ACTIVITY

A

Measure the length of the baby in each picture. Measure from the top of the head to the bottom of the body. Don't include the legs. There is a number under each picture. It tells you how many times larger or smaller the picture is than the actual baby. Use this number to figure out the true length of the baby.

EXAMPLE—The picture of the one-month baby is 1.3 cm long. The picture is 5 times larger than the actual baby. Therefore divide 1.3 cm by 5.
Actual length of one-month baby = 0.26 cm.

EXAMPLE—The picture of the 2-month baby is 1.3 cm long. The picture is ½ the size of the actual baby. Therefore multiply 1.3 cm by 2.
Actual length of 2-month baby = 2.6 cm.
Now do the 3rd through 9th months.



B

Make a graph showing how the baby grows in length over 9 months. Mark off 9 months along the bottom of the graph. Mark a scale of lengths on the left side. Mark the lengths for each of the 9 months on the graph. (The lengths for the first 2 months are shown.) Connect the points with a curving line to show how the baby grows.

5 CHEMICAL MESSENGERS

In a long experiment in Puerto Rico, several thousand women took birth control pills daily. Their ovulation and normal menstruation stopped.

word guide
pregnant
PREG-nuhnt

PLANNED PARENTHOOD/WORLD POPULATION

A woman cannot become **pregnant** while she is on the pill. Then, when she wants to become pregnant, she stops taking the pill. Therefore, couples may use the pill to choose the time of birth and the number of their children. The pill can be obtained only with a doctor's prescription.

1. Why does the pill prevent pregnancy?

Three American scientists developed the pill. They were seeking a new method of birth control to help couples plan when they would have their children.

The pill contains a mixture of sex hormones.

Hormones are chemical messengers. They travel through the blood. They tell the different parts of the body what to do. Hormones made by the ovaries and testes are called sex hormones.

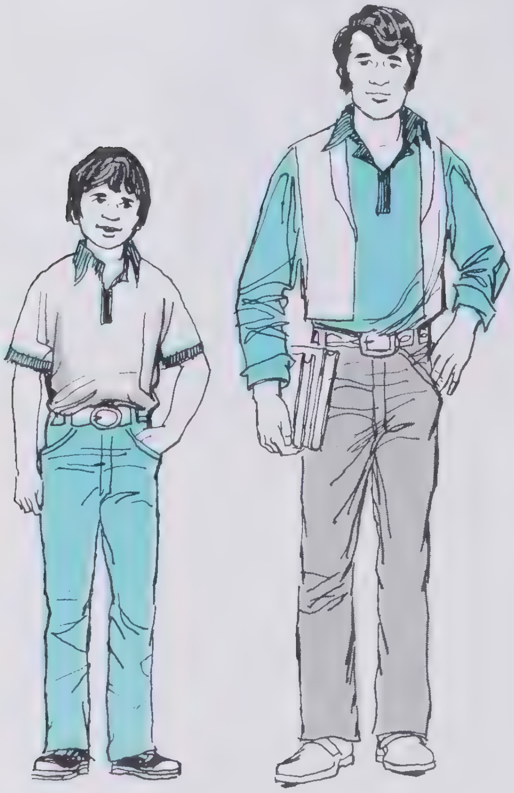
2. Why are hormones called chemical messengers?

A. GIRL TO WOMAN

The ovaries make 2 female sex hormones. These chemical messengers control changes in the uterus. They regulate ovulation and menstruation.

Between ages 10 and 14, a girl enters adolescence. Her ovaries produce larger amounts of sex hormones.

Her breasts develop. Her hips broaden. Hair grows on parts of her body. Her skin becomes smooth and soft. Feminine curves appear. The girl becomes a woman. Hormones are responsible for these changes.



B. BOY TO MAN

Between 12 and 17, male sex hormones cause a boy to change also. His penis grows. His testes start making sperm. His voice deepens. He develops a beard, bigger bones, tougher muscles, and broader shoulders.

Every male produces some female hormones, too. The effect shows in his nipples. Likewise every female produces some male hormones.

So no one is all masculine or all feminine. We each have a little of the opposite sex in our makeup.

C. WHAT DO YOU THINK?

Most people are very much interested in the topics discussed in this chapter. Some popular opinions about them are given below. What does your group think about the following quotations? Report to the class.

3. "The pill should be banned."
4. "Birth control methods should not be available to minors."
5. "Birth control methods should be available to married people."

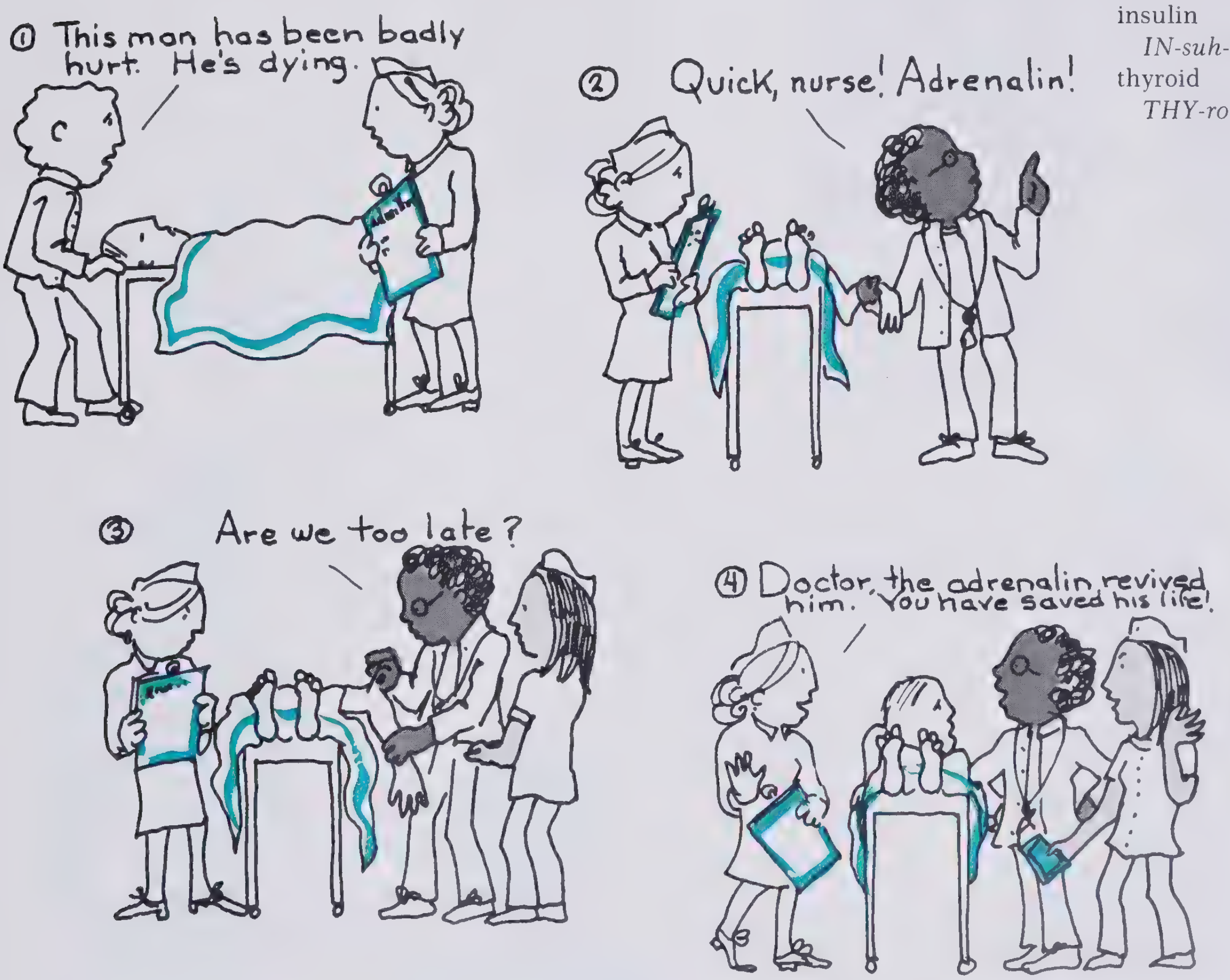
6 MORE MESSENGERS

Not all hormones are sex hormones. Let's see what other kinds of hormones there are.

There are many medical programs on television. They are very popular. Surely you have watched a scene like this.

word guide

adrenalin	*ad-REN-uh-lin*
asthma	*AZ-muh*
diabetes	*dy-uh-BEE-teez*
insulin	*IN-suh-lin*
thyroid	*THY-roid*


① This man has been badly hurt. He's dying.
② Quick, nurse! Adrenalin!
③ Are we too late?
④ Doctor, the adrenalin revived him. You have saved his life!

A. THE FIGHT-OR-RUN HORMONE

The doctor called for **adrenalin.** Adrenalin is a hormone made by the adrenal glands. There is one adrenal gland near each kidney.

Adrenalin speeds up the heart. It relaxes the lungs, and makes you breathe faster and deeper. It helps the blood to clot. It makes stored sugar pour into the bloodstream.

All these changes help the body deal with an emergency. This is why adrenalin is useful in case of heart attack.

People with **asthma** have difficulty breathing. Adrenalin helps them also.

The adrenalin that the doctor injects comes from a cow or pig. Hormones from these animals are almost the same as human hormones.

When you feel anger or fear, you are feeling the effects of your own adrenalin. It seeps into the blood from the adrenal gland. It helps you prepare for the danger facing you.

1. Why is adrenalin called the fight-or-run hormone?

FUSION MAGAZINE

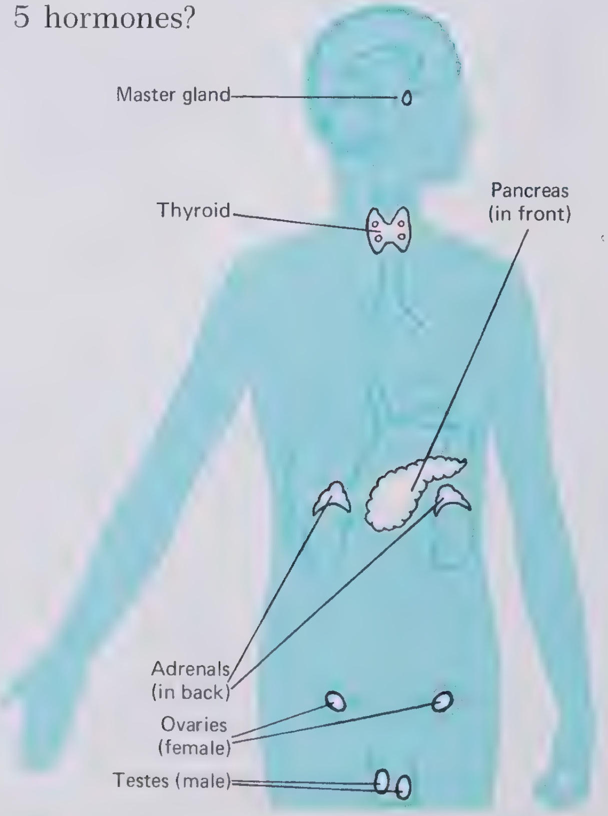
B. WHAT MAKES A SWINGER?

Thyroid hormone is made by a gland in the neck. People with a large amount of this hormone tend to have a lot of energy. Those with a smaller amount have less energy.

Every drugstore has a freezer full of **insulin.** This hormone comes from special parts of the pancreas gland.

Insulin helps the body burn up sugar and get energy. People with sugar disease or **diabetes** don't make enough insulin of their own. That is why many of them must take drugstore insulin daily.

2. Where do you think drugstore insulin comes from? (HINT: Remember adrenalin.)
3. Can you name 5 hormones?

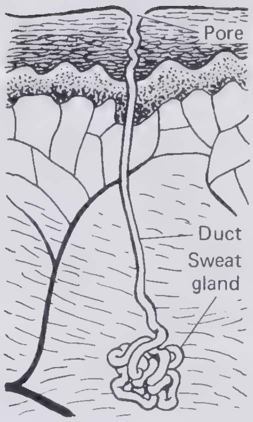


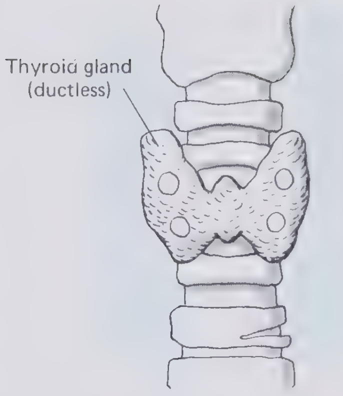
C. DUCT AND DUCTLESS GLANDS

Hormones are made by special glands. Most glands in the body send their products to the outside through a tube or duct.

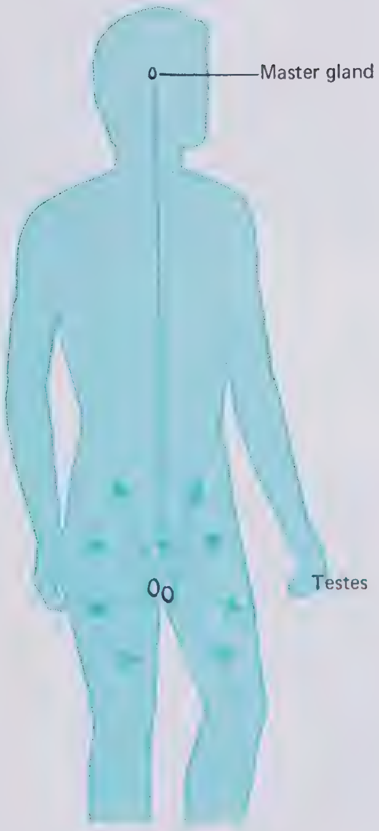
For example, glands in the mouth produce saliva. Sweat glands pour perspiration onto the skin. The kidneys send urine first to the bladder, and then it leaves the body.

Saliva, sweat, and urine are not hormones. These chemicals all flow through ducts.



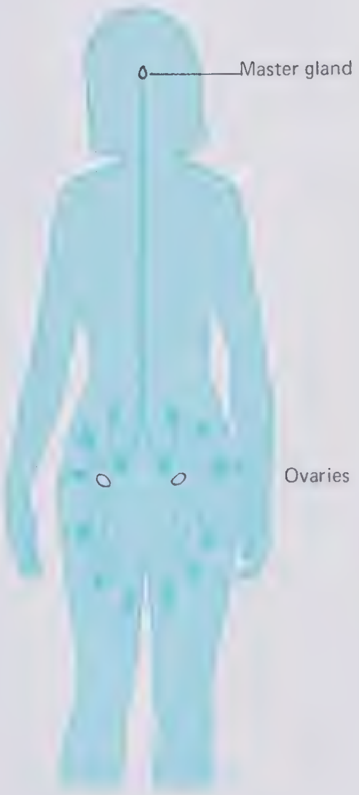


The glands that make hormones, however, have no ducts. Their hormones seep directly into the blood. The blood carries the hormones all through the body. The hormones can then affect the whole body. They are chemical messengers.



D. THE MASTER GLAND

Several different hormones come from a ductless gland in the middle of the head called the master gland. A main job of the master gland is to control other glands. Its hormones tell the ovaries and testes when to become active.



Sex and reproduction don't depend just on the sex organs. The head is involved too, through the master gland.

4. Why was the master gland given this name?

You can play bingo on the HORMONE-BINGO WORKSHEET. You may keep the book open to help you while playing.

Hormone-Bingo Worksheet

Select 16 terms from the list below. Make a copy of the bingo card shown below and write one term in each square. When the teacher calls out a question, see if the answer is one of your terms. If it is, place a marker on that square. Call out "BINGO!" when you have 4 markers in a line straight across, up and down, or diagonal.

hormone
master gland
chemical messenger
testis
male sex hormone
female sex hormone
ovary
uterus
menstruation
the pill
birth control
insulin
thyroid hormone
family planning
ovulation
adolescence
adrenalin
adrenal gland
sex hormones
diabetes

7 LOOK ALIKES

Do you know any twins? Some twins look so much alike that it is hard to tell them apart. These are **identical** twins.

DEBBIE SEAMAN

Other twins aren't alike at all. They just look like members of the same family. They may even be brother and sister. Such a pair are **fraternal** twins.

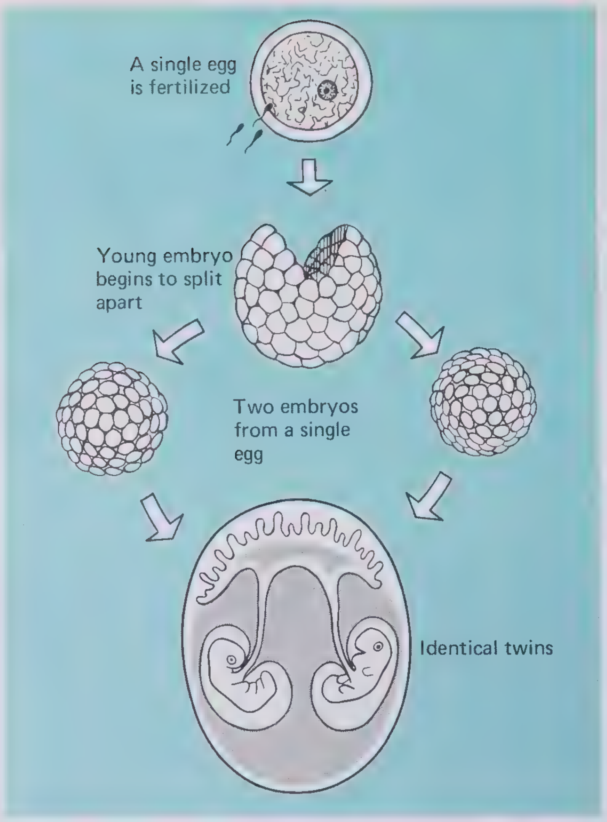
word guide

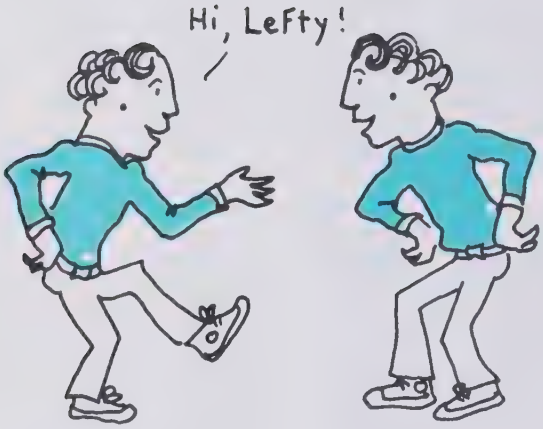
Dionne	*dee-ON*
fraternal	*fruh-TUHR-nuhl*
identical	*y-DEN-ti-kuhl*
multiple	*MUL-tuh-puhl*
quadruplet	*kwahd-ROO-plit*
quintuplet	*kwin-TUP-lit*
triplet	*TRIP-lit*

A. ONE-EGG TWINS

Identical twins come from the same fertilized egg. During their early development the embryo splits in two.

Each half-embryo then develops into a complete individual. In this development the twin embryos share the same placenta. Identical twins must be of the same sex.


A single egg is fertilized
Young embryo begins to split apart
Two embryos from a single egg
Identical twins



Sometimes the embryo splits rather late in development. The 2 half-embryos develop face to face. In such a case the left side of one twin may resemble the other twin's right side more than it does its own right side. Such twins are mirror images of each other.

Identical twins not only look alike, they are alike in other ways. Often they get the same illnesses at the same time.

Identical twins have sometimes taken the same test at the same time, but in different rooms. Any possible cheating was out. Yet the twins came up with the same answers to the same test questions.

1. How do you explain the close resemblance between identical twins?

Donna and Dinah were identical, one-egg twins. Most people could not tell them apart. Yet their parents, and close friends, could tell one from the other. There were very, very slight differences between them. After long, close observation, you could recognize the differences.

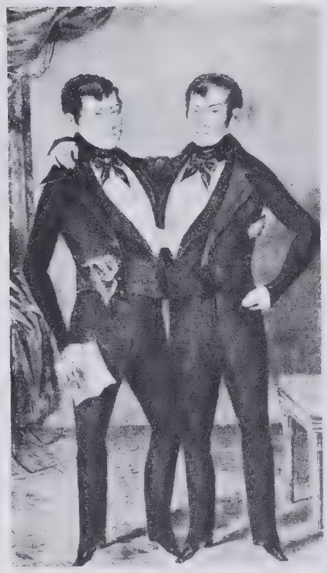
2. If Donna and Dinah were identical twins, explain the slight differences.

B. SIAMESE TWINS

Have you ever seen Siamese twins?

Siamese twins are identical twins that are attached to each other. Sometimes they can be cut apart. However, if their blood vessels and nervous systems are closely connected, or if they share a vital organ, they cannot be separated. They must stay together for life.

UNITED PRESS INTERNATIONAL PHOTO


THE BETTMANN ARCHIVE

Siamese twins don't necessarily come from Siam. They got that name because of a famous pair from Siam, Chang and Eng. Chang and Eng traveled with the circus for years.

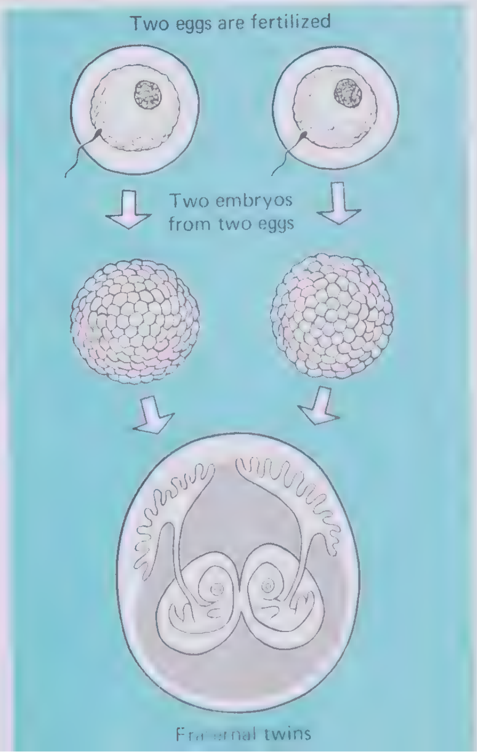
3. How are Siamese twins produced? (HINT: Look at the diagram of identical twins.)

C. TWO-EGG TWINS

4. You already know another name for 2-egg twins. What is it?

Fraternal twins result when the mother ovulates 2 eggs at the same time. Each egg is fertilized by a different sperm. (Enough sperm are present to fertilize thousands or millions of eggs.)

The embryos develop at the same time, but separately. Each has its own placenta.



Fraternal twins may be of the same sex or of different sexes. Biologically they are no more alike than any 2 children of the same parents. Of course, because they are of the same age and grow up together, they may have similar interests and habits.

5. Do twins get along with each other better than most brothers and sisters? Ask any twins that you know.

D. MULTIPLE BIRTHS

About one out of 85 births is a **multiple** birth. Twinning is the most common kind of multiple birth. Twinning is inherited and runs in families.

Very rarely, a multiple birth produces **triplets, quadruplets,** or **quintuplets.** These are sets of 3, 4, or 5 babies born at the same time. The sets may be identical or fraternal, in any combination.

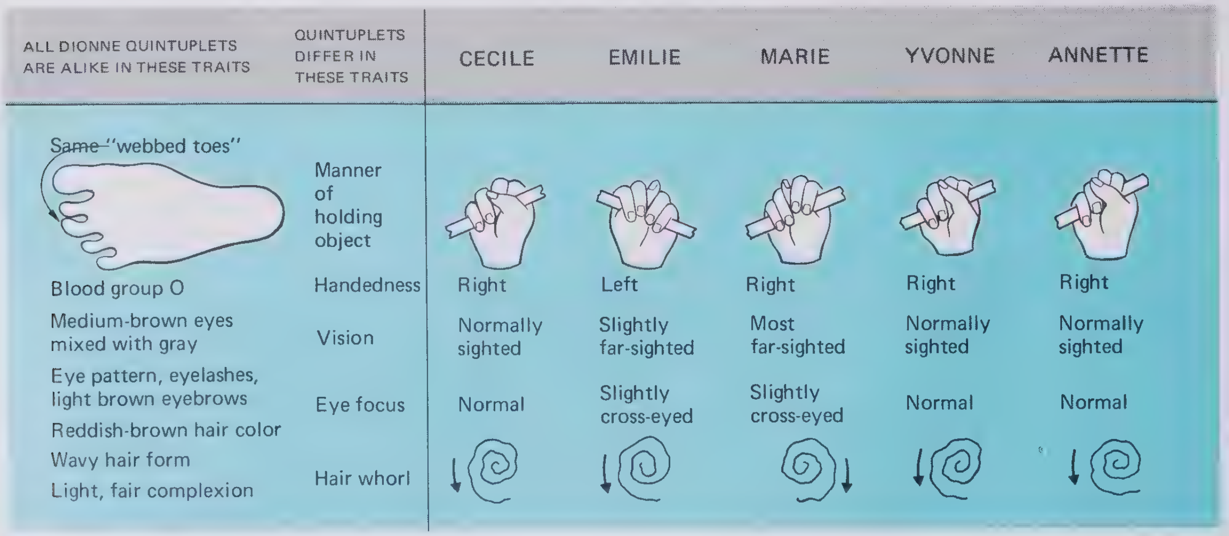
Babies from a multiple birth are usually smaller and weaker than single babies. Why?

Many quadruplets and quintuplets die shortly after birth.

One very famous Canadian set of quintuplets survived and grew up. These were the **Dionne** quints. They all survived mainly because of the care of a devoted doctor, Allan Dafoe. To learn more about quintuplets, look at the QUINT WORKSHEET.

Quint Worksheet

The table describes the famous Dionne quintuplets, according to the reports of Dr. Allan Dafoe. Examine the table carefully. Answer the questions below.



ALL DIONNE QUINTUPLETS ARE ALIKE IN THESE TRAITS	QUINTUPLETS DIFFER IN THESE TRAITS	CECILE	EMILIE	MARIE	YVONNE	ANNETTE
~~Same~~ "webbed toes"	Manner of holding object					
Blood group O	Handedness	Right	Left	Right	Right	Right
Medium-brown eyes mixed with gray	Vision	Normally sighted	Slightly far-sighted	Most far-sighted	Normally sighted	Normally sighted
Eye pattern, eyelashes, light brown eyebrows Reddish-brown hair color	Eye focus	Normal	Slightly cross-eyed	Slightly cross-eyed	Normal	Normal
Wavy hair form Light, fair complexion	Hair whorl					

1. Do you agree with Dr. Dafoe that the quints were all identical? Give your reasons.
2. Show by a diagram how you think the quints were formed.
3. Which girls separated last? Explain your choice.
4. Which quint is left-handed?
5. Twins normally occur about once in every 85 pregnancies, triplets once in every 85 × 85 pregnancies. How often would you expect quintuplets? Work out your answer.
6. What recently born quints have you heard about?

8

FLOWER POWER

You know that a seed can grow into a new plant. But where does the seed come from?

word guide

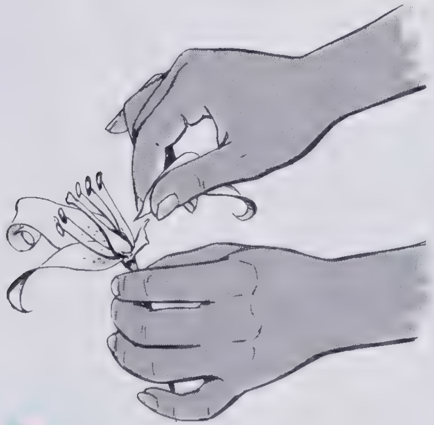
anther	*AN-ther*
pistil	*PIS-til*
pollen	*POL-uhn*
pollination	*pol-uh-NAY-shuhn*
stamen	*STAY-muhn*

Certain plants make seeds. All these plants also have flowers. Plants use their flowers and seeds for sexual reproduction. People don't have flowers. They don't make seeds.

However, sexual reproduction is somewhat the same, whether in flowering plants, animals, or people.

Do the FLOWER ACTIVITY. Find out how flowers and seeds are involved in sexual reproduction.

FLOWER ACTIVITY

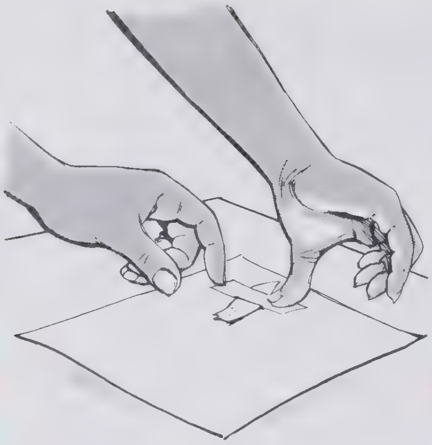


A

Look at your flower. Find the petals. Pull off all the petals.

B

Smell a petal.

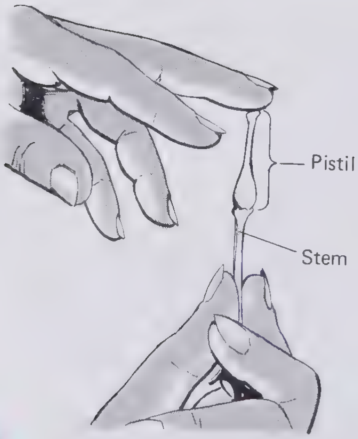


C

Tape the petals on a sheet of paper and label them.

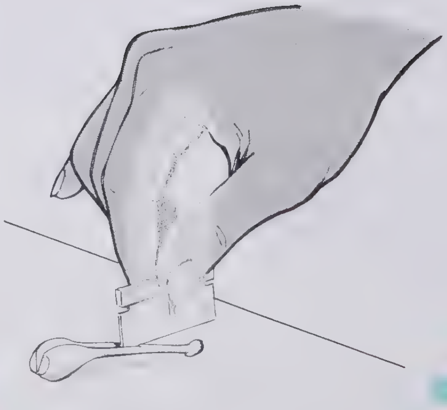
D

Some stalks are left. Notice one big stalk and several smaller ones. The smaller stalks are **stamens.** Remove the stamens.



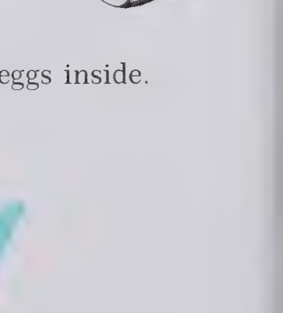
G

The big stalk left on the flower is the **pistil** or female part. Can you feel that the top is sticky?



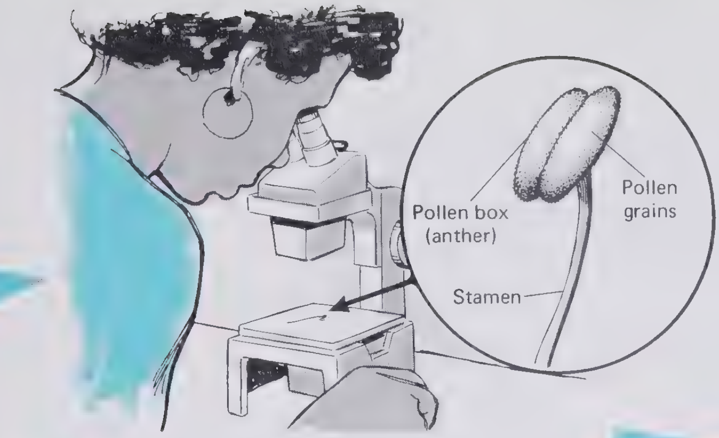
H

Remove the pistil. At its base is a round ovary. Carefully slice the ovary in half.



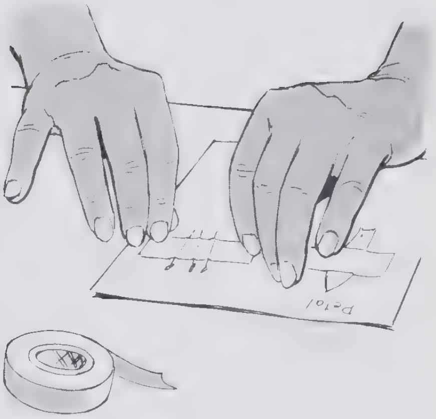
I

Find the eggs inside.



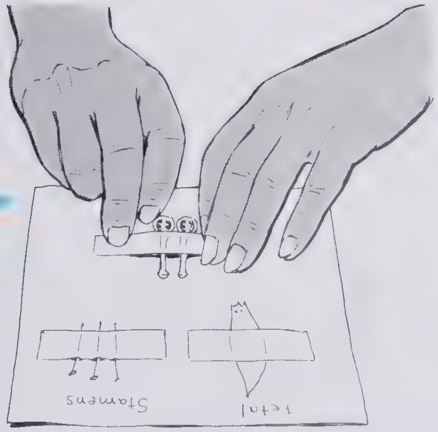
E

Examine one stamen under a microscope. Notice the **pollen** box or **anther** at the top. Yellow pollen grains cover it. Pollen grains are male cells.



F

Tape the stamens in your notebook and label them.

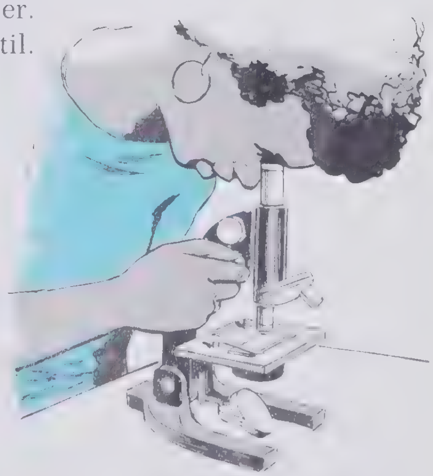


J

Tape the pistil in your notebook. Label it.

K

Examine another complete flower. Notice the pollen on top of the pistil. How do you think it got there?



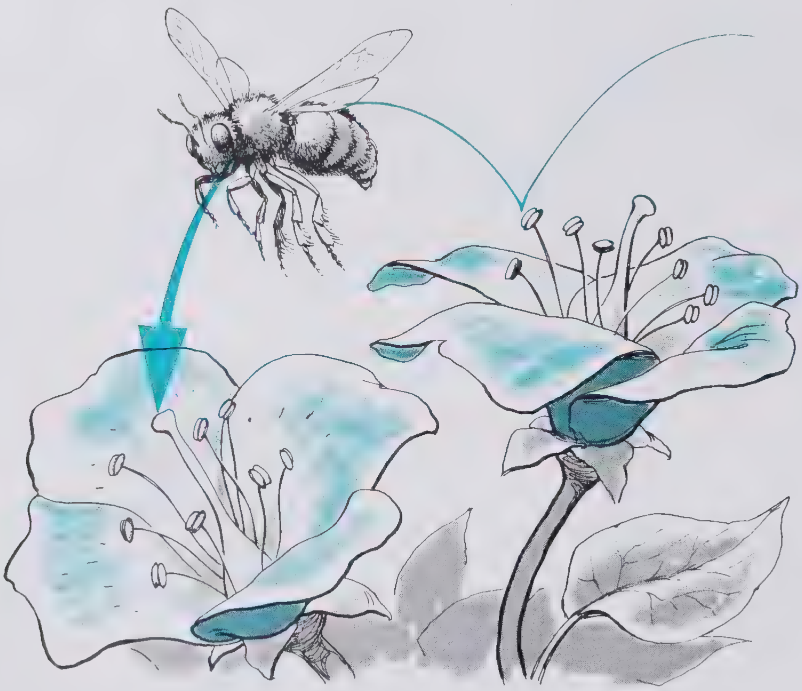
L

Yesterday some pollen grains were placed in a sugar solution. Examine them with a microscope.

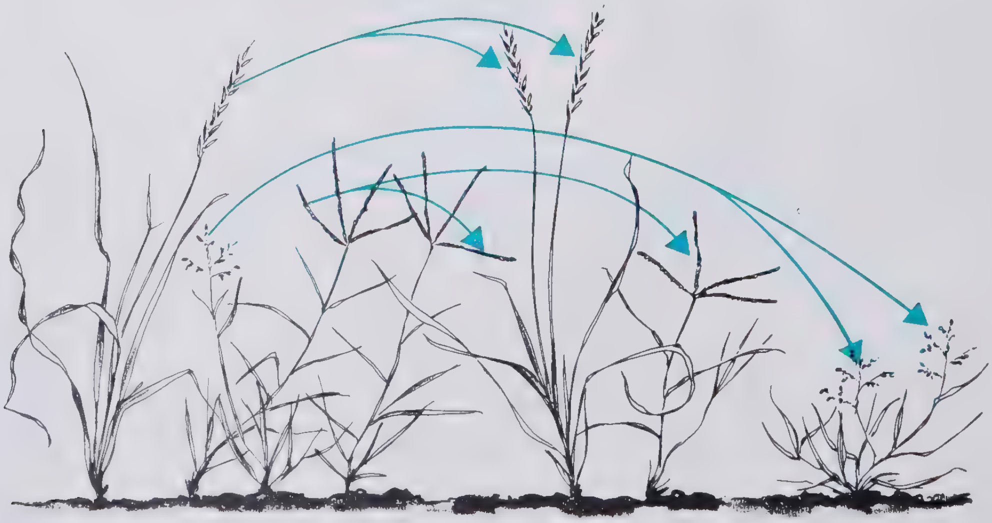
A. FLOWERS, WIND, AND INSECTS

You saw the eggs at the bottom of the pistil. These are female parts. The pollen grains on the pollen box or anther are male parts.

The pollen grains have to reach the eggs. They do this in 3 stages. First they get to the top of the pistil. This movement is called **pollination.**



Pollination by insects

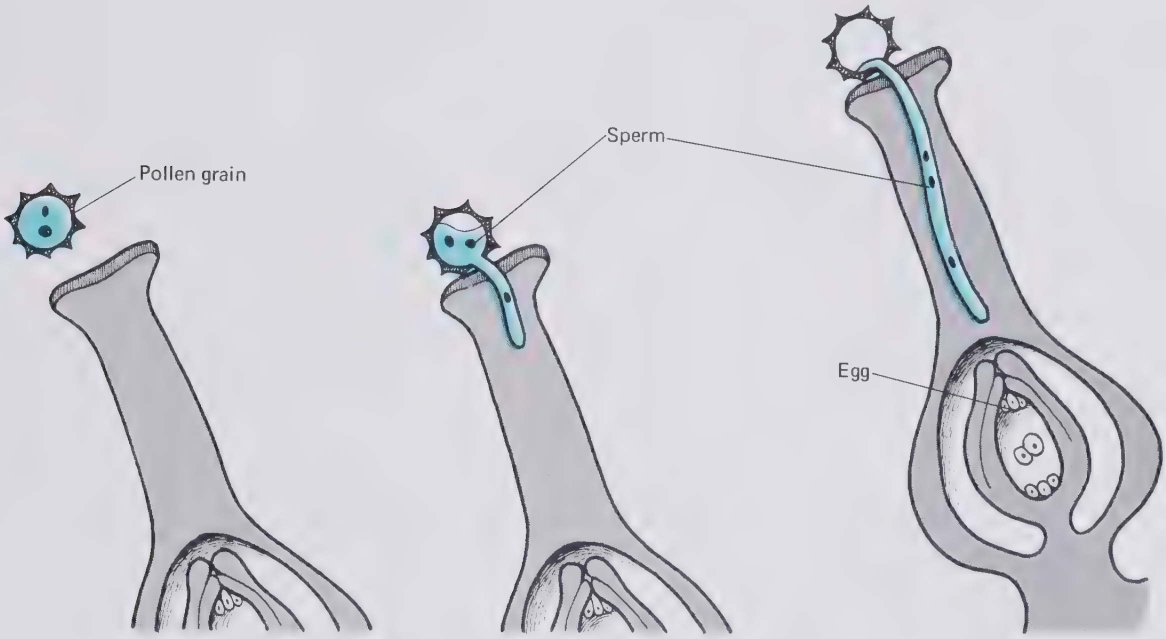


Pollination by the wind

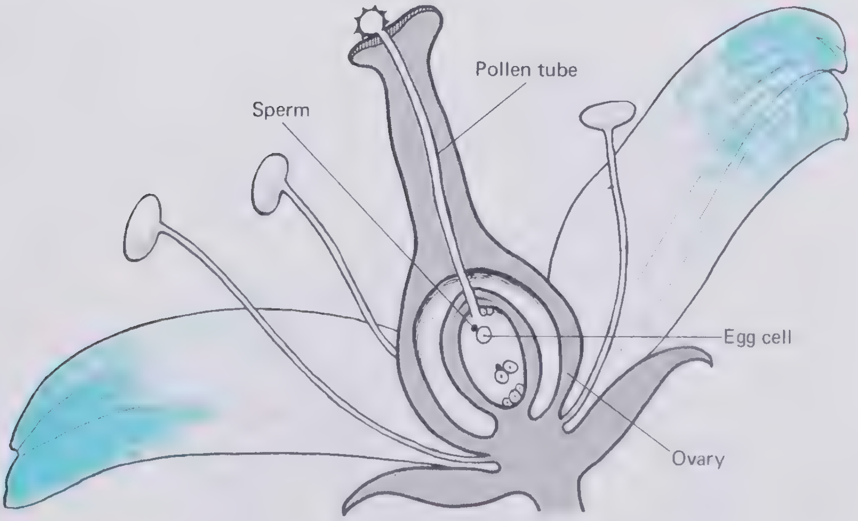
1. What is pollination?
2. In pollination, what carries the pollen?
3. Insects don't know about pollination. What attracts them to visit flowers?

B. THE SPERM FINDS THE EGG

Pollination leaves pollen grains on top of the pistil. They still have to reach the ovary where the eggs are. They do this by growing a long pollen tube down through the pistil. This is the second stage of the pollen grain's activity.

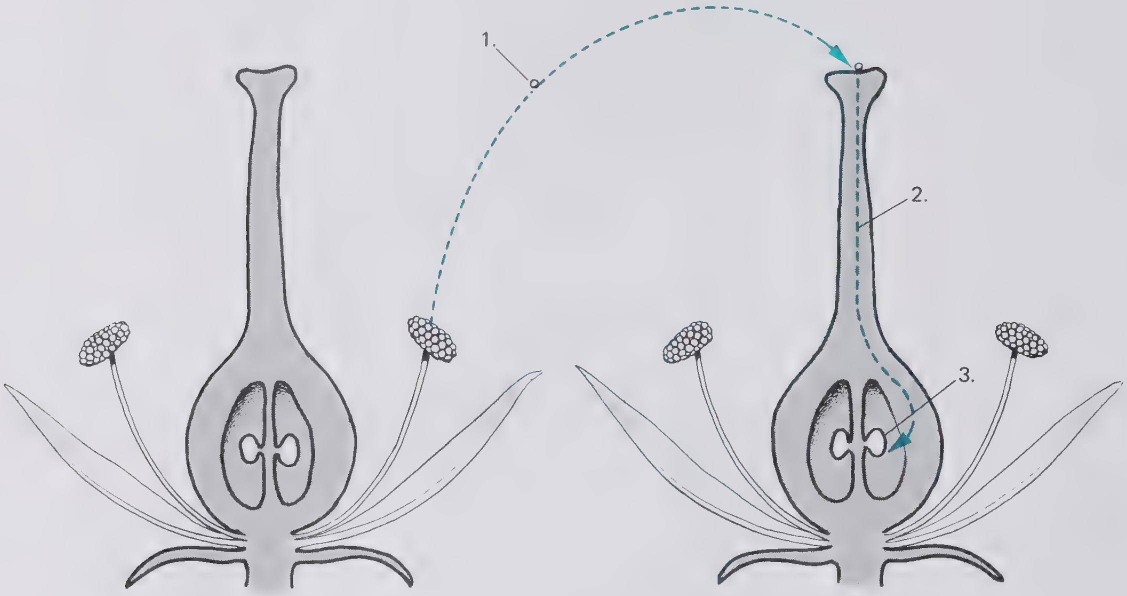


Sperm cells move down the pollen tube. A sperm cell joins each egg. This is the third stage.



4. When the sperm and the egg join, what is the process called?

5. The diagram below shows the 3 stages of reproduction that involve the pollen. Name the 3 stages.



Once the egg has been fertilized, it grows into a baby plant. The cells around the fertilized egg become the seed. The ovary becomes a fruit. Soon you will see how all this happens.

C. JOBS WITH FLOWERS

People love flowers for their bright colors and nice smell. They use flowers at weddings, funerals, and parties. They buy flowers for home decoration and as gifts. So flower shops and greenhouses where flowers are grown are a big industry. This industry can offer jobs and a future to many young people.

9 DON'T EAT THIS FRUIT

word guide
edible
ED-uh-buhl
inedible
in-ED-uh-buhl

Suppose someone offered you one of these and said: "Have a piece of fruit."

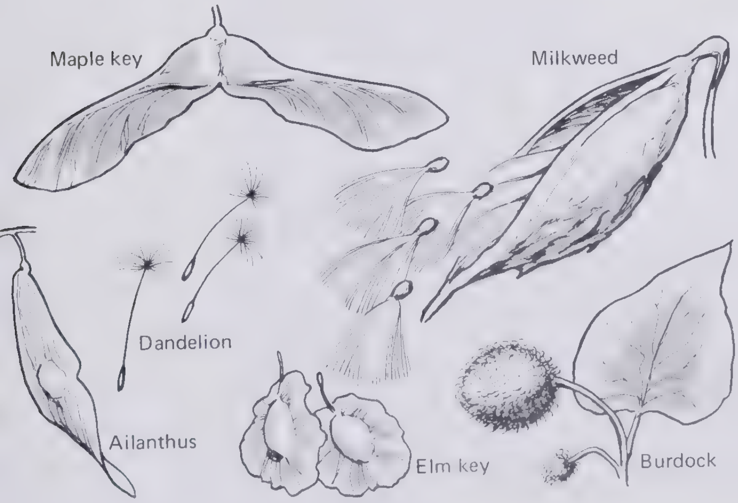
You might think he was putting you on. Perhaps you would get angry.

But nobody is kidding. One of these is the fruit of a little plant called the sticktight.

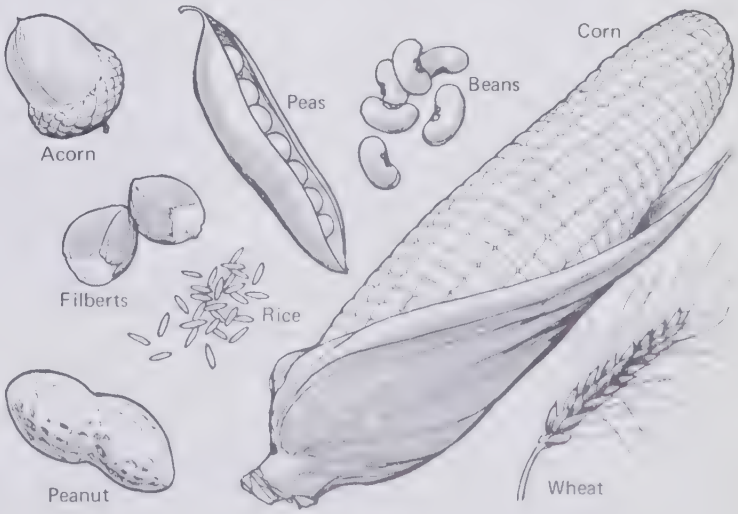
The other is a maple key, the fruit of the maple tree. Maybe you have opened maple keys and stuck them on your nose.

A. YES, A TOMATO IS A FRUIT

A fruit is the part of a plant that contains seeds. Some fruits are dry and **inedible.**



Other fruits are dry, but **edible.** We can eat them or the seeds they contain. There are also fruits that are juicy. They are sweet and nourishing, and we can eat them too.



Other fruits are juicy, but we don't eat them. We don't eat them for many reasons. They may be bitter or poisonous. They may not be very nourishing. Or, perhaps we just are not in the habit of eating them.

Now, about the tomato. People used to think it was poisonous. They called it the love apple.

Maybe some lovesick lad ate a tomato, thinking it would kill him. But he didn't die. In fact he liked the fruit.

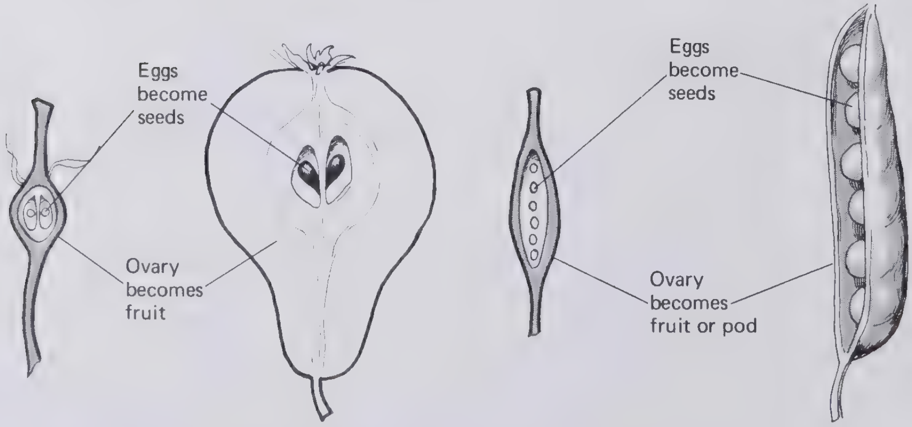
TO BE OR NOT TO BE

Now lots of people eat tomatoes. Tomato plants are easy to raise. They can be raised in your own back yard or in a vacant lot. They can even be raised in a big flower pot.

1. Why is a tomato a fruit?

B. WHERE FRUITS COME FROM

Remember how the egg is fertilized in a flower? Once the egg has been fertilized, it grows into a baby plant.



The cells around the fertilized egg become the seed. The ovary becomes a fruit.

All fruits come from the ovaries of flowers. All contain seeds. All seeds contain baby plants.

The seeds have to be scattered and planted. Sometimes farmers or gardeners do this. Sometimes the wind does the job, as happens with these winged dandelion seeds.

When the seeds reach fertile ground, the baby plants grow out. They become the new generation.

2. What do all seeds contain?
3. How are seeds scattered?

So a new plant starts with a seed. The plant grows out of the seed. It becomes mature. It produces flowers, then fruits and seeds, and the cycle starts over again.

C. FRUITS AND SEEDS TRAVEL

A fruit protects its seeds. It also helps the seeds travel to new places where they can start growing.

Sometimes the fruit travels with its seeds. Sometimes it remains near the mother plant and sends the seeds on their way alone.

As you do the FRUIT WORKSHEET, you can figure out some of the ways that fruits help seeds get started in life.

Fruit Worksheet

Copy the following table in your notes.

In the table, list the fruits given to your group. Some are edible, others are inedible.

For each fruit, fill in the table.

Ask the teacher to check your completed table. Then divide the edible fruits and eat them. (CAREFUL: Even in edible fruits, the seeds are sometimes poisonous!)

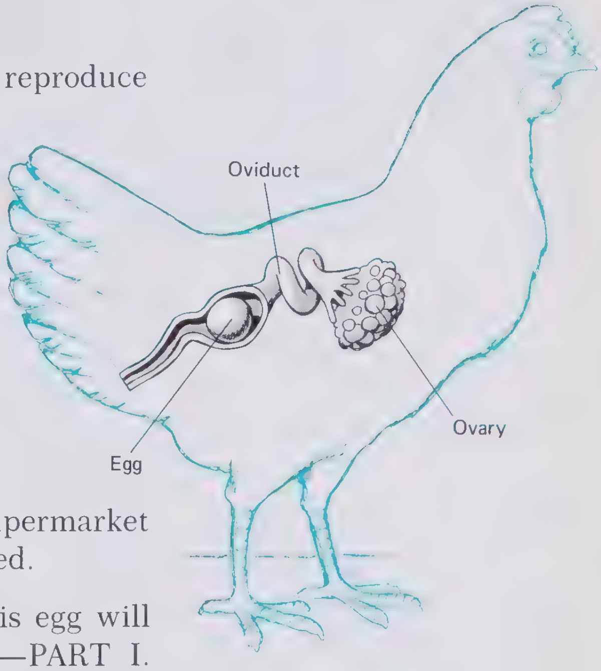
TABLE OF FRUITS AND SEEDS

Name of fruit			
Is fruit dry or juicy?			
Is fruit edible?			
Are seeds edible?			
Number of seeds?			
Are flower parts (sepals, petals, pistil, stamens) still attached to fruit?			
How is seed protected?			
Does fruit travel? How?			
How does seed travel?			

10 CRACKING EGGS

Chickens are birds. Birds, like frogs and human beings, reproduce sexually.

But hens' eggs are not fertilized in the water like frogs' eggs. Instead, the rooster puts some sperm inside the hen's body. Fertilization is internal.



A. THE SUPERMARKET EGG

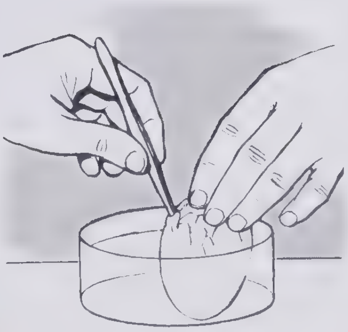
Let's start with some grocery biology. You will examine a supermarket egg that can never hatch because it has not been fertilized.

You may have eaten a lot of eggs in your life. But this egg will have some surprises for you! Do the EGG ACTIVITY—PART I. THE SUPERMARKET EGG.

EGG ACTIVITY—PART I. THE SUPERMARKET EGG

A

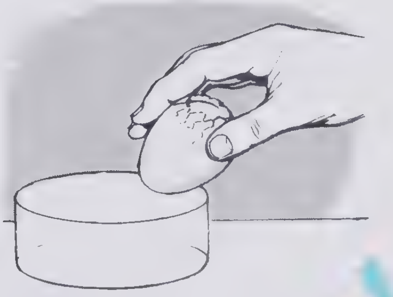
Gently crack the egg.



B

Carefully pick away the bits of shell.

1. Can you find membranes under the shell? What use do you think they are?

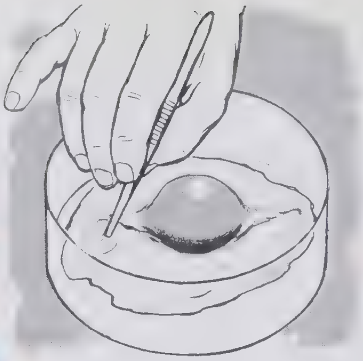


C

Crack the egg in the middle.

D

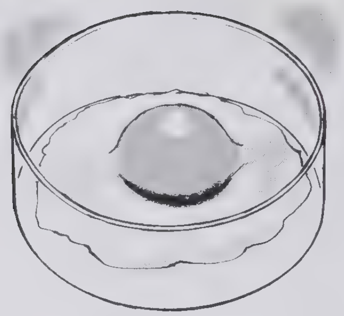
Gently pour into dish. The yolk and the white are foods.



E

Notice 2 twisted cords attached to the yolk. Pull them.

2. What use are the twisted cords?



F

The living part of the egg is a white speck on the yolk. Find it.

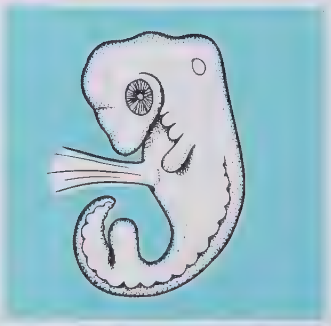
3. This egg could never have developed into a chick. Why not?

G

Copy the drawing on the EGG WORKSHEET. Label all parts.

B. THE CHICK STARTS

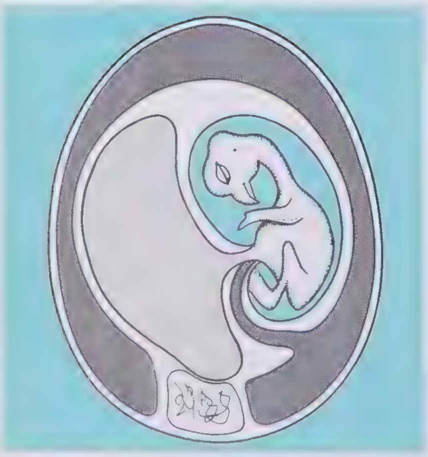
Now let's look at some eggs that are developing. Because they have been fertilized, they contain chick embryos. They will help you to see how an egg becomes a chicken.



The teacher put some fertile eggs in the incubator about 3 weeks ago. Others were incubated for shorter periods.

So the eggs are at different stages of development. Each group will open one of the eggs. Be sure to examine all stages.

C. THE CHICK DEVELOPS



In the eggs that have been incubating longer, you will see some of these parts:

developing head
developing brain
definite eyes
beating heart
wing buds
leg buds
tail
bag enclosing the embryo
bag containing wastes
blood vessels spreading over the yolk
blocks of muscle running down the back

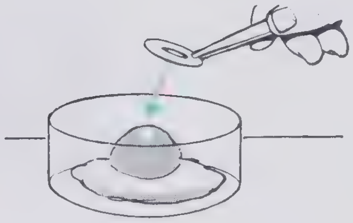
If the egg is kept warm and wet, the heart will beat and the embryo will stay alive for many hours. Copy the chart on the EGG WORKSHEET. Then do EGG ACTIVITY—PART II. THE FERTILE EGGS. Indicate on your chart the day of incubation when each part or event is first seen.

EGG ACTIVITY—PART II. THE FERTILE EGGS

FOR EGGS INCUBATED 5 DAYS OR LESS

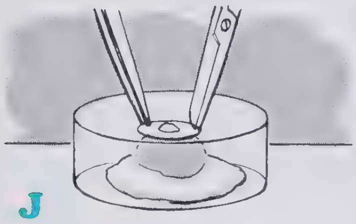
H

Open egg into a dish as you did the supermarket egg.



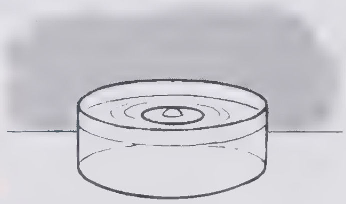
I

Move the yolk so that the embryo is on top. Cut a paper ring. Fit it on the yolk around the embryo.



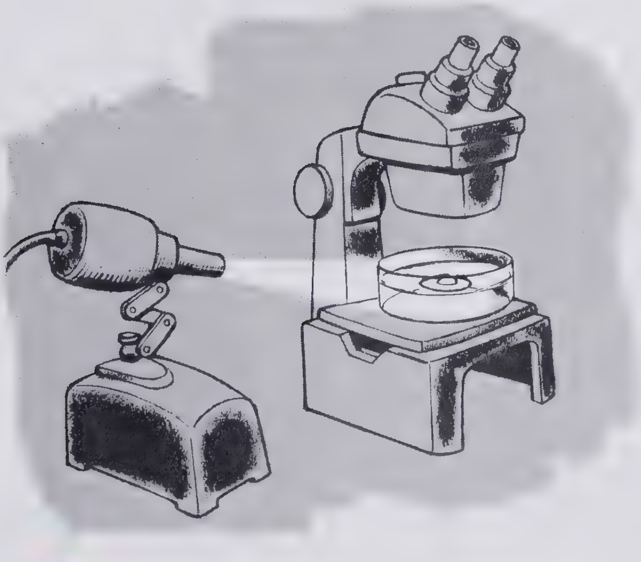
J

Cut around outside of ring. Lift out ring. The embryo will come out with it.



K

Float ring and embryo in dish of salt water.



L

Examine the embryo with lens or microscope.

4. Can you find the large, bent brain?
5. Can you find 2 bulges on the brain that will form the eyes?
6. Can you find the heart? Is it beating? How fast?
7. What other parts can you find?

FOR EGGS OLDER THAN 5 DAYS

M

Crack egg directly into dish of warm salt water.

Observe different stages and finish the chart from the EGG WORKSHEET.

Some eggs will be left in the incubator to hatch. If you are lucky, you may see some wet little birds climb out.

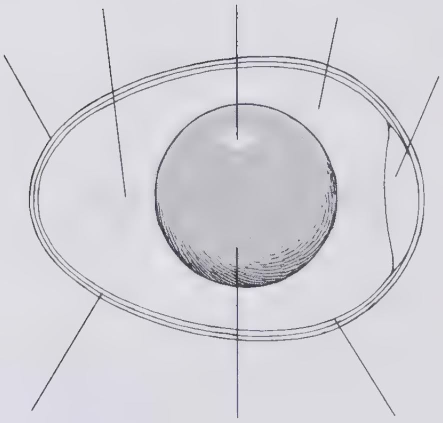
D. EGGSHELL SCULPTURE

Here is a cool way you can use leftover eggshells. Try making some eggshell sculptures better than these.

SUSAN WEINBERG

Egg Worksheet

A SUPERMARKET EGG



CHICK DEVELOPMENT

Part or Event	Day of Incubation When First Seen
Brain	
Beating heart	
Definite eyes	
Blood vessels	
Wing buds	
Leg buds	
Tail	
Sac enclosing embryo	
Sac containing wastes	
Muscle blocks	
Movement of chick	

11

THE HIGHEST ANIMALS

All animals with backbones are called vertebrates. There are different kinds of vertebrates.

Birds are one kind. Fish, frogs or amphibians, and **reptiles** are other kinds.

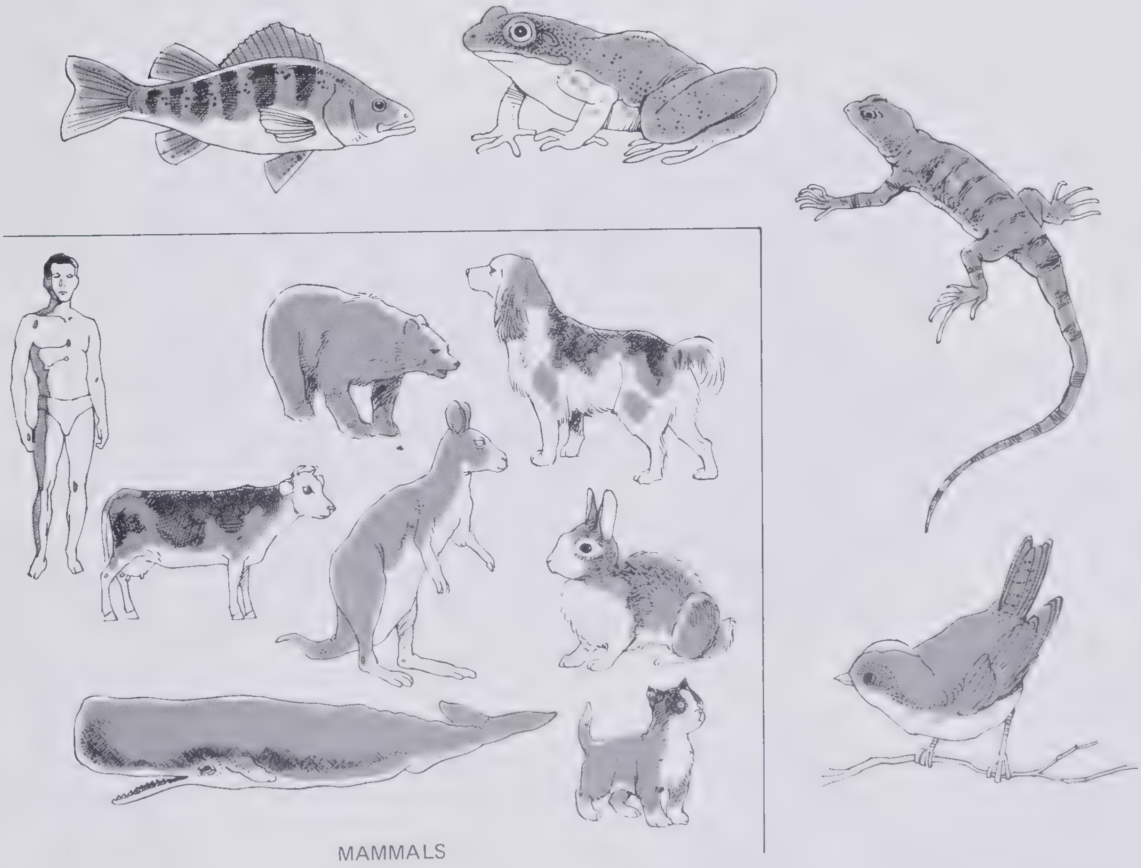
word guide

aggressive	*uh-GRES-iv*
mammal	*MAM-uhl*
reptile	*REP-tyl*
veterinarian	*vet-ruh-NAIR-ee-uhn*

A. WHAT, ME A MAMMAL?

We belong to the kind of vertebrate called **mammals.** Dogs, horses, rabbits, mice, bears, elephants, and whales are mammals. Human beings are mammals.

VERTEBRATES

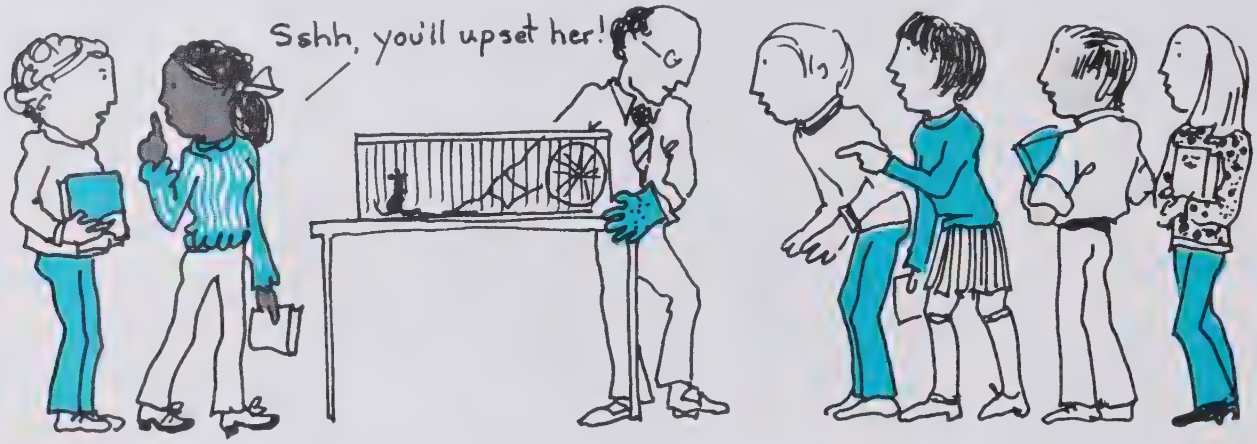


Mammals have hair or fur. The females nurse their young. All mammals resemble human beings in their special method of reproduction.

You can learn a lot about mammal reproduction by watching a young mammal family.

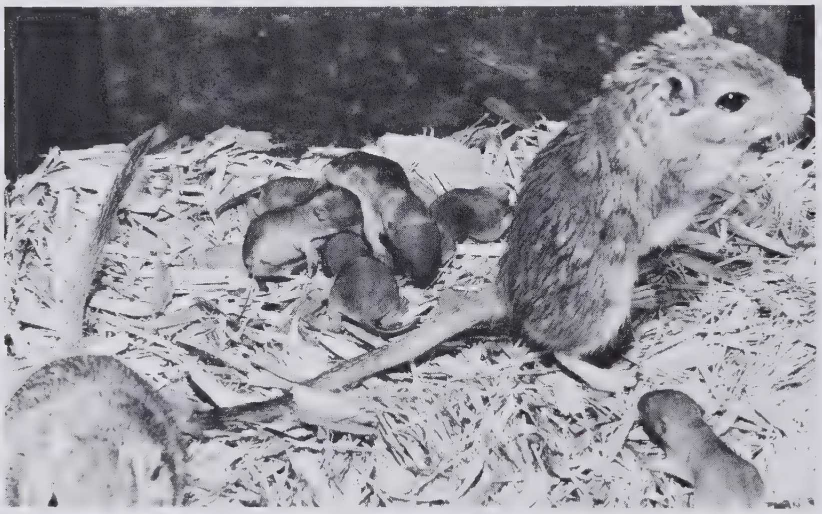
B. WATCHING THE FAMILY

You will observe mouse, hamster, or gerbil mothers caring for their recently born young. The mother and her litter may be alone in a breeding cage. If the father is present, or if the mother is disturbed in any other way, the young will be poorly cared for. The mother might even eat them.


Sshh, you'll upset her!

Mothers with young are **aggressive.** For her protection and yours, follow these directions when you are near the cage.

Make no noise. Move slowly. Don't tease the little animals. If you put your hand in a cage, wear a heavy glove.



Gerbils

Look at the nest. If you can't see it, gently move the bedding aside until you can.

1. How do you think the nest was made?

Watch the young.

2. Do they have hair? Are their eyes open? Are they clumsy or graceful? What do they do?
3. If you see any of them nursing, describe it.
4. Do you see any evidence of independence in the young? Is there any fighting?

C. WHAT PARENTS ARE GOOD FOR

Watch the mother.

5. How does she care for her young? Does she ever reject the young?

Mammals are said to be the highest and most intelligent vertebrates.

6. What makes you think this is true?
7. How is mammal reproduction different from any other kind of reproduction?
8. Can you see why high intelligence, and a lot of baby care by the mother go together?

Perhaps you know something about mammal development and baby care from watching pets. Perhaps you have learned a lot by looking after younger brothers and sisters.

Share this personal experience with your group and with the class.

D. WORKING WITH MAMMALS

Farmers work with animals. Even if you live in the city, there are many jobs available that involve caring for animals.

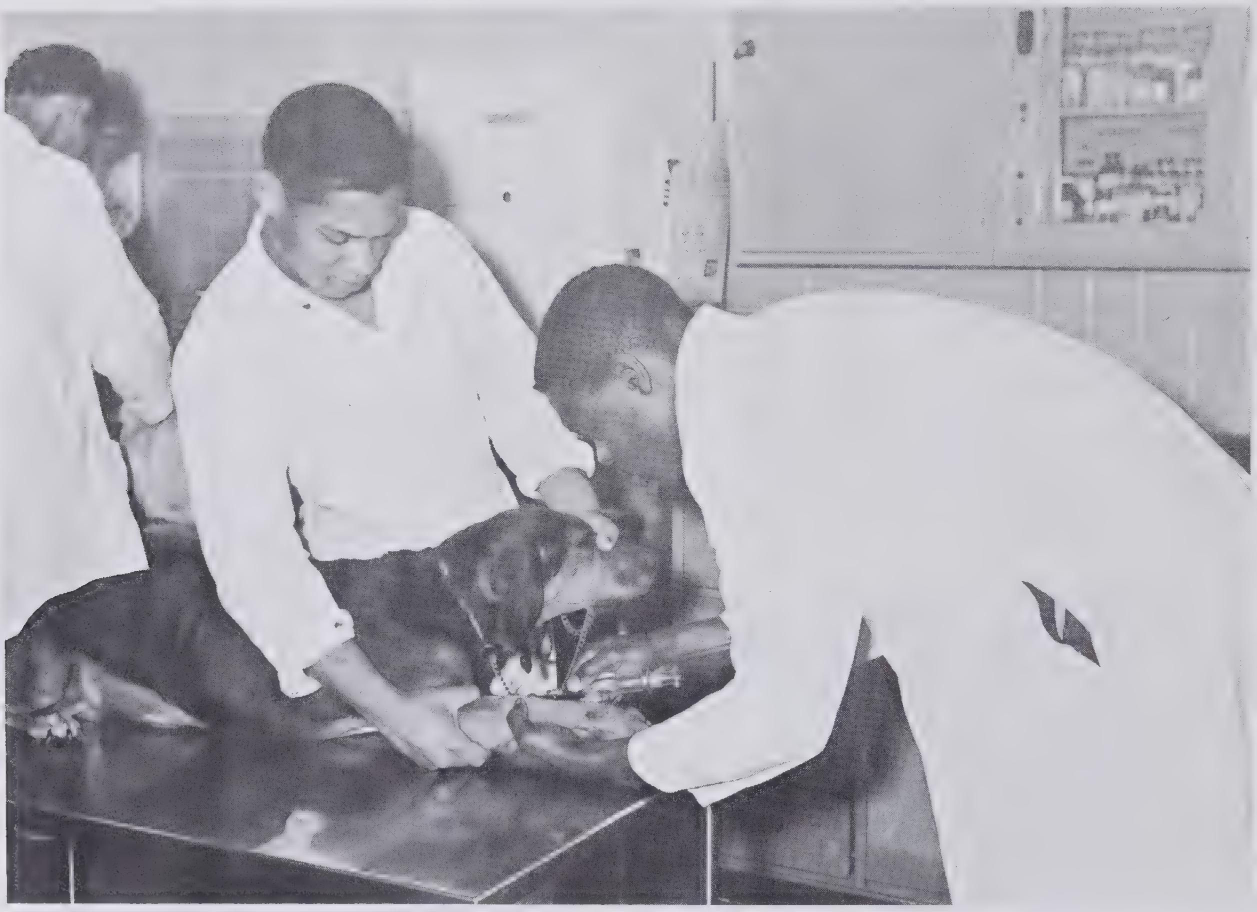
Perhaps a job as an animal caretaker or **veterinarian** may interest you.

Zoos, pet shops, and medical research labs are also places that need animal keepers.

COURTESY OF MASSACHUSETTS S.P.C.A.

Vets are animal doctors. They must go to college, and then to a veterinary medical school. It is difficult to be admitted to these schools and the training is long.

However, vets often employ assistants who like animals even if they don't have professional training.



TUSKEGEE INSTITUTE–SCHOOL OF VETERINARY MEDICINE

12 MASCULINE AND FEMININE

word guide

feminine
FEM-uh-nin
masculine
MAS-kyoo-lin

You're so masculine.
You're so feminine.

Here are some opinions about boys and girls, men and women. Which of the quotes make sense to you? Which don't make sense?

"The game is described as dating; boys take out girls, girls have to be asked, boys have to ask, the date must be conducted in some way so that it can be known to the rest of the group—otherwise it doesn't count."

—Margaret Mead, a scientist

UNITED PRESS INTERNATIONAL

"Woman's place is in the home."

—old saying

but I like art.

"I like art. I want to take an art course, but my father won't let me. He says art is for sissies."

—high school boy

"A man doesn't have to be tough and aggressive. He can be gentle and still be **masculine.**"

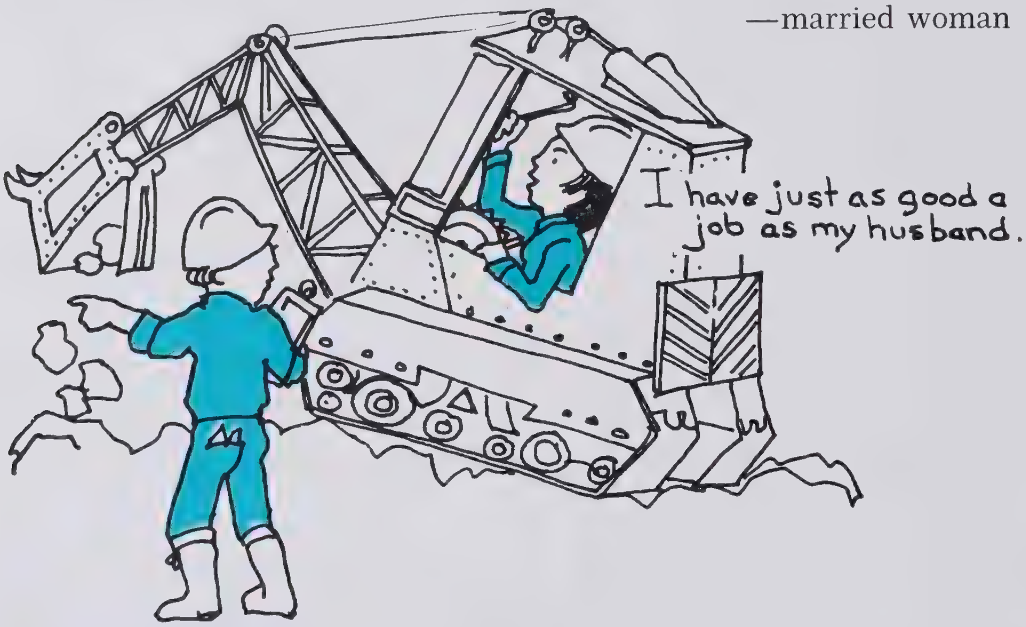
—a psychologist

"I want my daughter to marry young, keep house, and respect her husband. A woman isn't really a woman unless she has a husband and a family."

—a mother

"I have as good a job as my husband. I go under my own name, not his. I'm just as much a person as he is."

—married woman


I have just as good a job as my husband.
44

"A girl likes her guy to boss her a little, and make the decisions. It makes her feel more **feminine.**"

—high school boy

"Many girls act feminine not because they want to but because they are supposed to. The same is true for boys acting masculine. They all fit into a mold."

—high school girl

"We want girls to take shop and boys to take home economics. Some will like these courses. All students will come to understand better the role of the other sex."

—a principal

"I wouldn't be caught dead cooking or sewing. That's for girls."

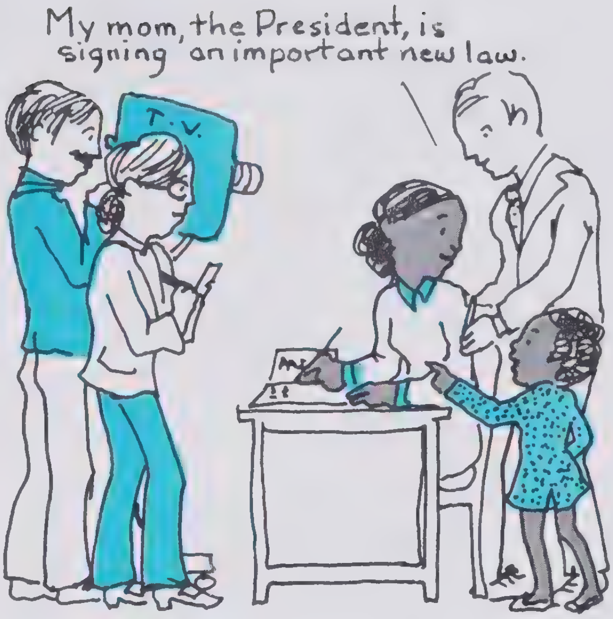
—high school boy

"For men must fight and women must weep."

—from an old poem

"If we had a woman president the country would run better."

—a woman


My mom, the President, is signing an important new law.
T.V.

What do you think? To give your opinion, copy numbers 1 to 40 from the MASCULINE-FEMININE WORKSHEET in your notes and answer each question.

When you finish, compare your opinions with others in your group.

Check the items you think the class would like to discuss.

Masculine-Feminine Worksheet

Who Should Do the Following?	Boy	Girl	The Sex Doesn't Matter
1. hold a job			
2. get better grades			
3. smoke a pipe			
4. change a tire			
5. dress well			
6. be an engineer			
7. be a jockey			
8. sew			
9. baby-sit			
10. be aggressive			
11. be a doctor			
12. be interested in art			
13. be stronger			
14. work on a car			
15. keep house			

Who Should Do the Following?	Boy	Girl	The Sex Doesn't Matter
16. have long hair			
17. read love stories			
18. be shorter			
19. cry in public			
20. play touch football			
21. be good looking			
22. read about sports in the paper			
23. be a nurse			
24. make more of the decisions			
25. carry the other person's books			
26. open doors for the other			
27. use makeup			
28. pay for dates			
29. have more money			
30. go to a dance alone			
31. phone the other more			
32. take shop in school			
33. take home economics in school			
34. ask for a date			
35. kiss his or her father			
36. be a plumber			
37. drive a cab			
38. deliver the mail			
39. be a typist			
40. wear jewelry			

13 ACTING IT OUT

Here are some scenes from real life. Only the beginning of each scene is given. Act out the ending.

SCENE ONE—WHY CAN'T HE?

MOM—She works when she can, but she is sick a lot. She just can't seem to get all the housework done. She wants Cliff, her teenage son, to help with the cooking and laundry. He refuses. She doesn't see why he won't help out.

CLIFF—He is 16. He isn't about to do girls' work. The guys will kid the shirt off him.

LIZ—She's 10. She already does a good deal of the housework to help out Mom. Why can't Cliff do his share? After all, he lives in the house too.

Please help your sister, Cliff.
Aw, Mom.
POP CORN

SCENE TWO—PIVOT OR BLOW THE SAX

JOE—He's a fair pivot man, but he doesn't like basketball that much. He blows the sax and he really digs music. His band has a date the night of the big basketball game. His parents are bugging him about which he should go to. What will he say to them?

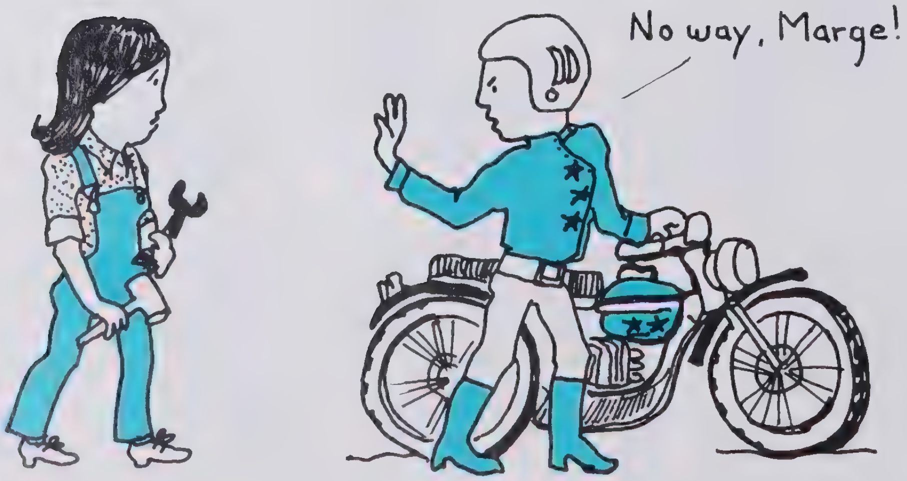
POP—Sports are for men. Music isn't. He wants that boy to play ball and forget about his dopey music.

MOM—Throwing a ball through a hoop isn't the only way to be masculine. Joe loves music. He should have a chance to do his thing.

SCENE THREE—THE LADY MECHANIC

MARGE—She enjoys riding with Butch, her steady, on his motorcycle. She knows as much about the wheel as he does. She'd like to work on it, but Butch won't let her touch it. Butch keeps telling her that machines aren't for women. She doesn't want to lose Butch. How can she handle her problem?

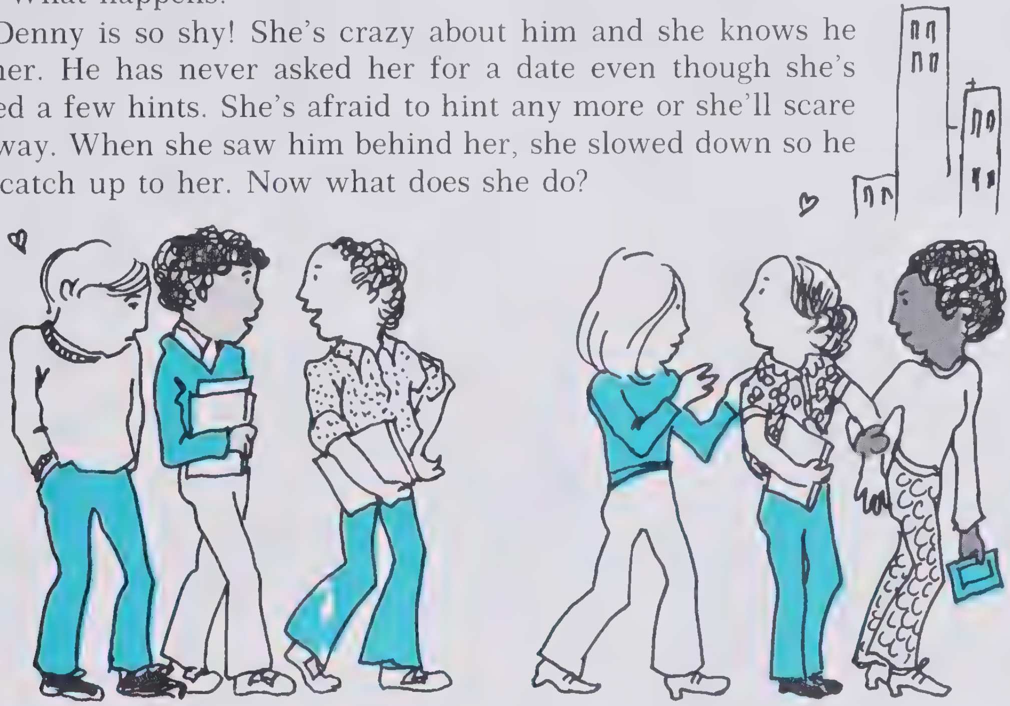
BUTCH—He likes Marge a lot. But he just can't see a girl, in greasy coveralls, working on a motorcycle. He doesn't want to go with a girl mechanic. What will he do?


No way, Marge!

SCENE FOUR—THE FIRST MOVE

DENNY—He's a big hunk of man, but girls scare him. He has liked Patty for a long time, and he thinks she likes him. He has never had the courage to ask her for a date. He wishes she would ease the way. He catches up with Patty as she is walking down the street. What happens?

PATTY—Denny is so shy! She's crazy about him and she knows he likes her. He has never asked her for a date even though she's dropped a few hints. She's afraid to hint any more or she'll scare him away. When she saw him behind her, she slowed down so he could catch up to her. Now what does she do?



SCENE FIVE—CHICKEN

CHUCK—He's small and wiry. He doesn't have a very deep voice. But he certainly isn't a sissy. He's out with a bunch of guys and girls, when they catch up with a boy from another crowd. Chuck's bunch surround the kid. Big Bill tells Chuck, "Hit the lug or you're chicken." Chuck knows he can lick the other boy, but he doesn't see any reason for beating the kid up. Is he chicken?

BILL—He doesn't like Chuck. Any guy who won't mix it when he has the chance is chicken. He's going to show up that sissy, Chuck.

SANDY—She likes Chuck. She respects him. He's nice and he's gentle. He's masculine without being a bully. How can she help him out?

SCENE SIX—WHO PAYS?

BOB—He likes Maria. He wants to take her out on a date. But he has no money and he doesn't want to look cheap. It's rough getting a job. So he just stays away from her.

MARIA—She knows Bob likes her. She would love to go out with him. He never asks her, probably because he hasn't any money. She'd be willing to split the cost of a date. But how does she tell him this? She is afraid he won't take money from a girl and his pride would be hurt.

You've been play-acting. But the roles in the scenes are also roles in real life. Here are some questions that will help you to understand your role as a girl or a boy.

1. Did the roles in the scenes come naturally, or did the kids learn them from society?
2. Should any of the roles be changed?
3. Do roles help you to become masculine or feminine?

14 BOY OR GIRL

You know that men and women look different. Their reproductive organs are different. Their behavior as men and women is different.

These differences are built into every cell of the body.

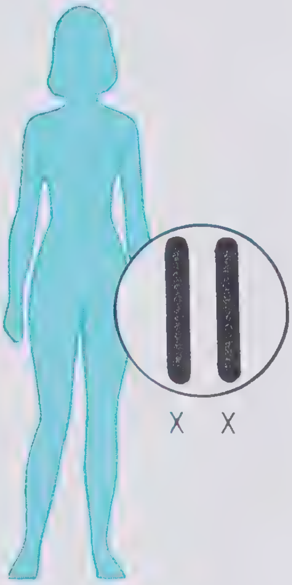
word guide

chromosome
KROH-muh-sohm

A. CELLS ARE MALE OR FEMALE

Every cell has a nucleus. In the nucleus there are several dark-staining rods called **chromosomes.**

Human cells have 46 chromosomes each. In each cell 2 of the chromosomes are called sex chromosomes. The sex chromosomes decide whether a person is male or female.



In each cell of a female the 2 sex chromosomes are long, like this. They are called X chromosomes. Two X chromosomes per cell make her a female.

A male's sex chromosomes look like this. Notice that one of the chromosomes is long. It is an X chromosome, just like a female's.

The other sex chromosome in each of a male's cells is short. It is called a Y chromosome. A combination of one X chromosome and one Y chromosome per cell makes him a male.

Simple, isn't it? But let's not make it too simple. Remember that besides the 2 sex chromosomes, each cell has 44 other chromosomes that have nothing to do with the person's sex.

B. BOY BABY OR GIRL BABY?

A family has a new baby. Immediately the neighbors ask, "Is it a boy or a girl?"

They know that the baby's sex was decided long before birth.

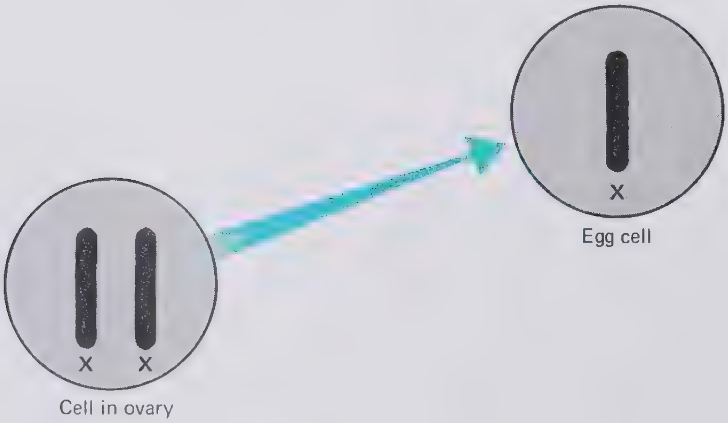
How was the baby's sex decided? What gave the baby 2 X chromosomes in each cell, or an X and a Y?

The BOY OR GIRL GAME will answer these questions. You will choose the sex of some make believe children in the game, the same way nature does for real children.

C. SOME GROUND RULES

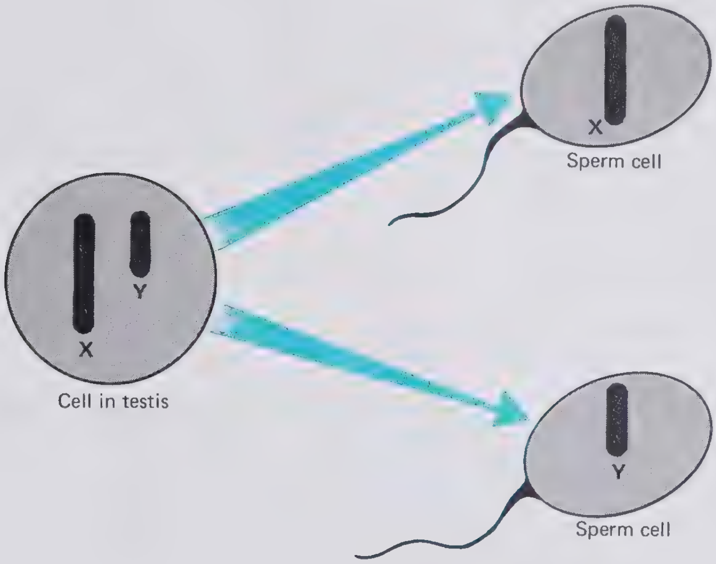
Remember that a baby begins to develop when an egg is fertilized by a sperm. The egg is made in the mother's ovary. Cells in the ovary have 46 chromosomes, or 2 sets of 23 chromosomes each. This includes 2 X chromosomes.

When the egg is made, it receives only one set of chromosomes. So it has only one X chromosome.



The father makes sperm cells in his testes. Like the egg, each sperm receives only one set of chromosomes. It gets only one sex chromosome. But here there is a difference. The sex chromosome in the sperm cell can be an X, or it can be a Y.

So the egg can be fertilized by a sperm with an X chromosome, or by a sperm with a Y.



1. If the egg meets an X-carrying sperm, what kind of baby results?
2. If the egg meets a Y-carrying sperm, what kind of baby results?

D. PLAYING THE GAME

With these rules clear, you and your partner are ready for the BOY OR GIRL GAME.

Draw this table in your notes.

X X	X Y

You will get an envelope labelled Mother. In the envelope there are a lot of cards representing eggs produced by the mother. Each card is marked with an X.

You will get another envelope labelled Father. In this envelope there are cards representing sperm cells. This time half the sperms are marked X, and the other half are marked Y.

3. Why?

Fertilize the eggs, one at a time. Shut your eyes. With one hand take an egg card out of the "Mother" envelope. With the other hand take a sperm card out of the "Father" envelope.

Give the 2 cards to your partner. If both cards are marked X, he or she should put a check under XX in the table. If one card has an X and the other a Y, the check goes under XY.

Do this 25 times. Then let your partner do it 25 times.

4. Do you see a short cut that will give you the same results?
5. How many boys did you count? How many girls?
6. What was the percentage of boys? The percentage of girls?

E. SO WHAT DOES IT MEAN?

Let's get back to the question the game was going to answer.

7. How does nature determine the sex of the baby?

Give the teacher your answers to question 5. Add up the answers from the whole class.

8. What percentage of boys did the whole class produce? What percentage of girls?
9. Were the class percentages the same as yours? Explain any difference.

After playing the BOY OR GIRL GAME, you will enjoy these discussion questions:

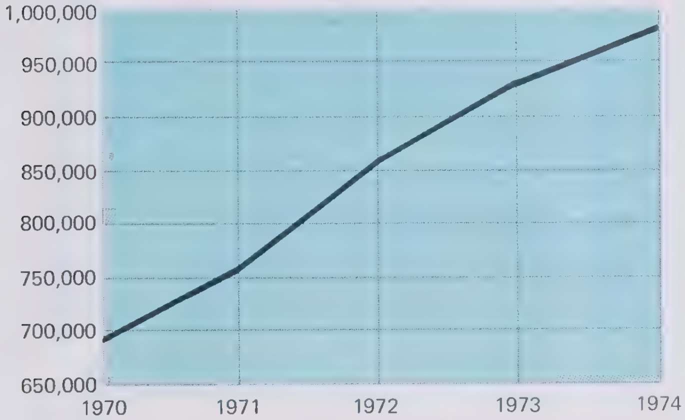
10. Why is there about an equal number of boys and girls in the world? (There isn't an equal number of men and women, because on the average, men die younger.)
11. The King of Iran wanted a son. He had only daughters. He blamed his wife for this. Was he fair?
12. How do you explain that some families have only girls or only boys?

15 THE SILENT HANGUP

What are teen-age hang-ups? Drugs? Needing a job? **Delinquency?** Playing truant from school? Fighting with your folks?

One big hang-up is VD—**venereal** disease.

A million people are reported to get VD each year. Half of these are young people. The true figures are much higher, because many cases are not reported.



Reported Cases of Gonorrhea and Syphilis in the United States

VD kills 3,000 people directly each year. Heart disease resulting from VD kills many others later in life.

On the average, one teen-ager gets infected with VD about every 2 minutes. And the rate of infection is rising. Is VD a hangup?

word guide

antibiotics	*an-ti-by-OT-iks*
arthritis	*ahr-THRY-tis*
chancre	*SHANG-kuhr*
contagious	*kuhn-TAY-juhs*
delinquency	*di-LING-kwuhn-see*
gonorrhea	*gon-uh-REE-uh*
paralysis	*puh-RAL-uh-sis*
spirochete	*SPY-ruh-keet*
syphilis	*SIF-uh-lis*
venereal	*vuh-NEER-ee-uhl*

A. DO YOU KNOW THE ANSWERS?

Maybe you know all this. If you already know about VD, perhaps you can check on the correctness of these statements:

The only true venereal diseases are **syphilis** (syph) and **gonorrhea** (clap).
Gonorrhea is something like a bad cold.
You can get VD from a dirty towel or an infected toilet seat.
You can get syphilis only once.
You can get good, safe treatments for VD in a reliable drugstore.
An unborn baby cannot get VD.
When the sores of syphilis disappear, you are cured.
You cannot have syphilis and gonorrhea together.

All of these statements are false.

If you knew this, and knew for sure why the statements are wrong, then you won't learn much from this chapter.

If, like most of your classmates, you are a little uncertain, then you have something useful to learn.

B. VENEREAL DISEASE

What are the facts?

VD is **contagious.** This means that it is caused by germs. The germs—and the disease—pass from one person to another through sexual intercourse, or through direct personal contact.

The germs thrive in the body. They die quickly outside of the body. Thus they cannot live long on a towel or a toilet seat.

There are 5 different venereal diseases. They are ancient and worldwide. However, syphilis and gonorrhea are the most common.

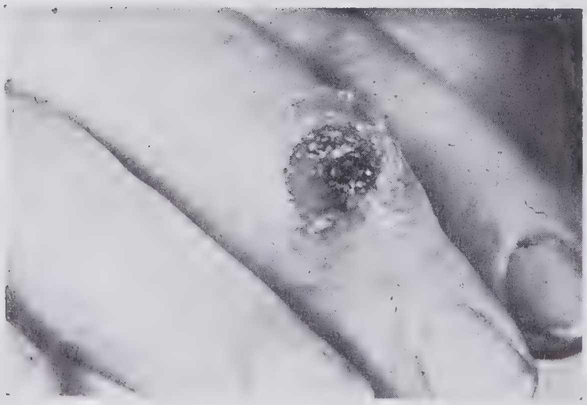
There is no long-lasting immunity to VD. Someone can be infected with syphilis and/or gonorrhea, be cured, and then get the disease again and again.

C. SYPHILIS

The cause of the disease is a corkscrew-shaped germ called a **spirochete.**

Syphilis is not inherited. But a pregnant woman may pass the germ through the blood to her unborn baby.

CENTER FOR DISEASE CONTROL—ATLANTA, GA.



U.S. COMMUNICABLE DISEASE CENTER: ATLANTA, GA.

When syphilis is unchecked, the disease goes through 3 stages. First a sore called a **chancre** appears. This develops usually, but not always, on the reproductive organs. It disappears in 2 or 3 weeks.

Two or 3 months later the second stage appears. This involves a skin rash, falling hair, fever, a sore throat, or other signs.

Eventually the symptoms go away. The person thinks he or she is cured.

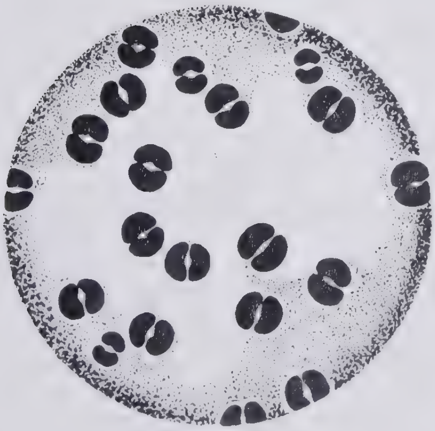
But the person is not cured. The spirochetes have hidden deep in the body. Years later they may bring on the third stage. The germs may cause heart, kidney, or liver trouble; blindness, **paralysis,** insanity, damage to the face, deafness, or sterility.

U.S. COMMUNICABLE DISEASE CENTER: ATLANTA, GA.

Syphilis in the third stage is a great imitator of other diseases. This is its most serious danger.

D. GONORRHEA

This disease is caused by a germ shaped like 2 coffee beans. An infected mother may pass the germ to her baby's eyes during birth.



In men the first sign is burning during urination, then a drip from the penis.

A woman may have gonorrhea for months and not know it. The signs of infection are internal.

Later on, in both sexes, gonorrhea may cause sterility. It may also cause **arthritis** or joint disease; heart disease, or blindness.

E. WHAT CAN WE DO?

From these descriptions, VD doesn't sound like much fun. It isn't. What can be done about the problem?

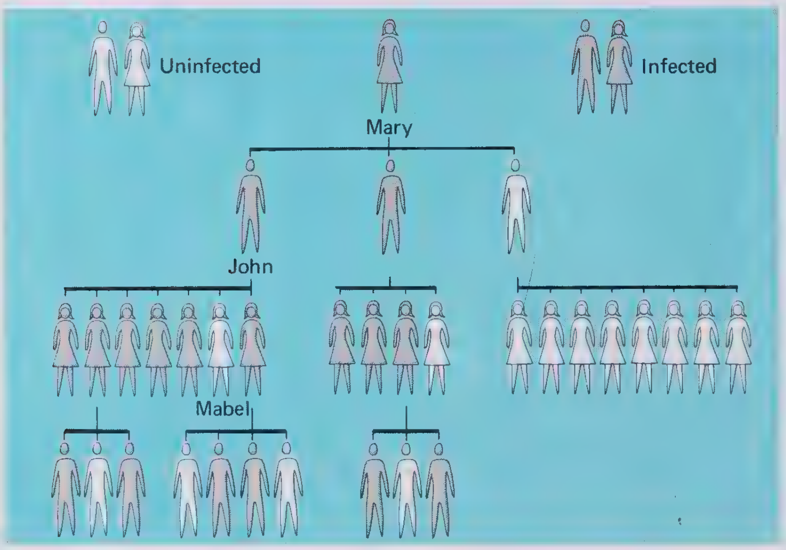
Most states have laws that help a little. The doctor must drop penicillin in the eyes of every newborn baby to prevent gonorrhea. Before getting a marriage license, a couple must have a blood test to detect syphilis.

But these laws don't help a teen-ager who may be infected.

Suppose a guy or a girl does find symptoms of VD. It is important to go immediately to a doctor or to a clinic. Don't treat yourself. You are not a doctor. Don't look for drugstore cures. There are none. Don't wait! VD won't go away by itself.

The doctor will order some lab tests. These tests will tell if the patient has VD. Then the doctor can treat the patient with **antibiotics,** or other medicines. Treatment can cure VD in the early stages. If treatment is delayed, however, permanent damage may result.

If a patient has VD the doctor will ask for his or her sexual contacts. Such information should be given. It will be used to make a chart of VD infection like this.



Everyone's cooperation will protect those who didn't know that they were infected.

1. How is VD different from most contagious diseases?
2. Why is syphilis called the great imitator?
3. Would you suggest any changes in the laws about VD? What changes?
4. In the chart of VD infection, why is John infected? Why is Mabel not infected?
5. Go back to Section A. Why is each of the statements incorrect?

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DATE DUE SLIP

DUE EDUC FEB 17'88
FEB 22 RETURN
DUE EDUC MAR 07'88
MAR 08 RETURN
DUE EDUC JAN 26'89
JAN 20 RETURN
DUE EDUC FEB 19'89
FEB 13 RETURN
DUE EDUC OCT 08'89
SEP 25 RETURN
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NOV 15 RETURN
DUE EDUC JAN 24'90
DUE EDUC FEB 07'90
JAN 27 RETURN
DUE EDUC FEB 15'90
FEB 22 RETURN
F255

DUE EDUC MAR 19'90
MAR 17 RETURN
DUE EDUC APR 23'90
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